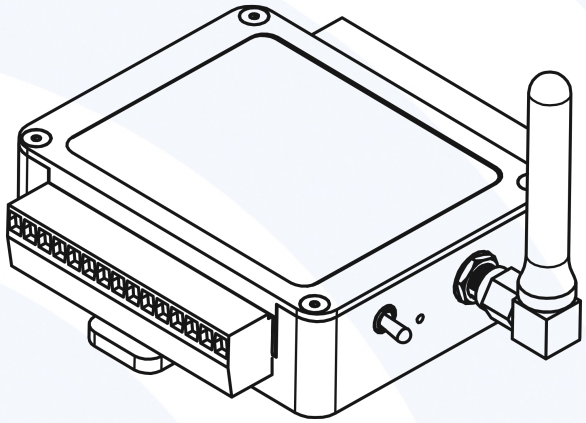
LORD USER MANUAL

V-Link® -LXRS®

Wireless 7 Channel Analog Input Sensor Node



LORD MicroStrain®
SENSING SYSTEMS

© 2014 LORD Corporation
MicroStrain® Sensing Systems
459 Hurricane Lane
Suite 102
Williston, VT 05495
United States of America

Phone: 802-862-6629
Toll Free: 800-449-3878
Fax: 802-863-4093

http://www.microstrain.com
sensing_support@LORD.com
sensing_sales@LORD.com

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1. Wireless Sensor Network Overview

The LORD MicroStrain® Wireless Sensor Network is a high speed, scalable, sensor data acquisition and sensor networking system. The system consists of wireless sensor interface nodes, a data collection gateway and full featured user software platforms based on the LORD MicroStrain® Lossless Extended Range Synchronized data communications protocol (LXRS®). Bidirectional wireless communication between the node and gateway enables sensor data collection and configuration from up to two kilometers away. Gateways can be connected locally to a host computer, or remotely on local and mobile networks.

The selection of available nodes allow interface with many types of sensors, including accelerometers, strain gauges, pressure transducers, load cells, torque and vibration sensors, magnetometers, 4 to 20mA sensors, thermocouples, RTD sensors, soil moisture and humidity sensors, inclinometers, orientation and displacement sensors. Some nodes come optionally with integrated sensing devices. Sensor sampling capabilities are IEEE 802.15.4 compliant and include lossless synchronized sampling, event based or burst sampling, streaming and data logging. One gateway can coordinate many nodes, of any type, and multiple gateways can be managed from one computer with the Node Commander® and SensorCloud™ software platforms. Integration to customer systems can be accomplished using OEM versions of the sensor nodes and by leveraging the LORD MicroStrain® data communications protocol.

Common applications of the LORD MicroStrain® Wireless Sensor Networks are wireless strain sensor measurement, wireless accelerometer platforms, wireless vibration monitoring, wireless energy monitoring, wireless environmental monitoring and wireless temperature monitoring.

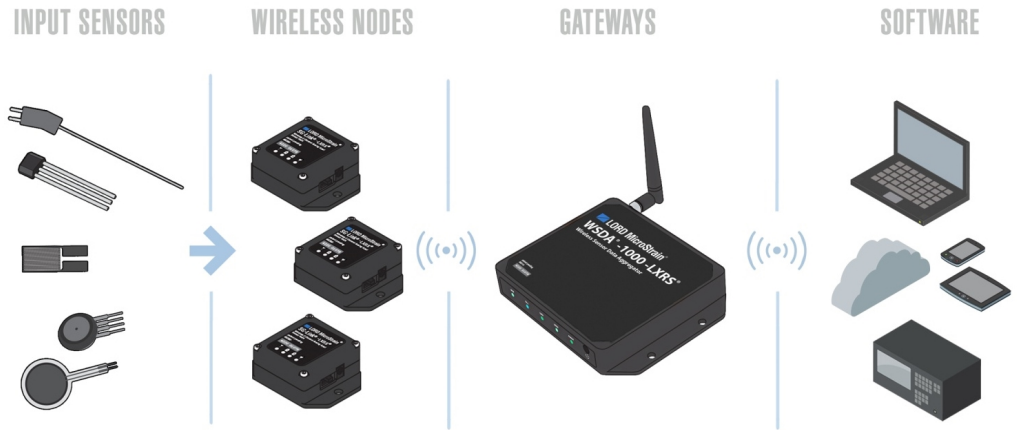


Figure 1 - Wireless Sensor Network Overview

2. Node Overview

The V-Link® -LXRS® wireless sensor node features seven analog input channels designed to accommodate a wide range of Wheatstone bridge and analog sensors including, strain, load cell, torque, pressure, acceleration, vibration, magnetic field, displacement, geophones and more. There are three channels for single ended sensor measurement, four channels for differential sensor measurement, and an on-board internal temperature sensor.

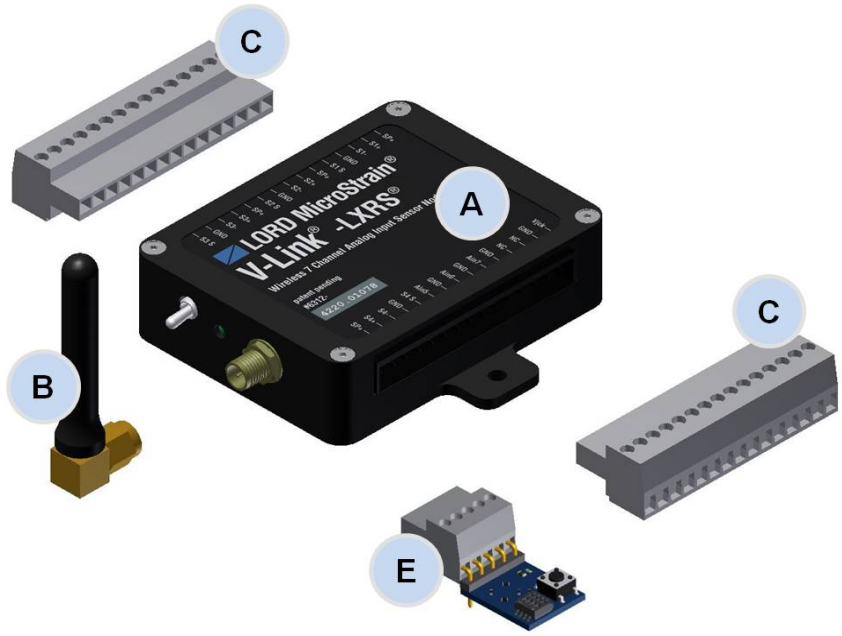
V-Link® -LXRS® inputs are 16-bit resolution with ± 0.1% full scale measurement accuracy. The node can log data to internal memory, transmit real-time synchronized data, and supports event driven triggers with both pre- and post- event buffers.

To acquire sensor data, the V-Link® -LXRS® is used with any LORD MicroStrain® data gateway, such as the WSDA® - Base and WSDA® - 1000, and either the Node Commander® or SensorCloud™ software interfaces, or a user designed program. The Node Commander® software is included with the gateways and allows configuration of the node.

Figure 2 - V-Link® -LXRS® Wireless Sensor Node

2.1 Components List

V-Link® -LXRS® sensor nodes come with the following components and options. For a complete list of available configurations, accessories, additional system products and ordering information see "Parts and Configurations" on page 62.



Item	Description	Quantity
A	V-Link® -LXRS® Wireless Sensor Node	1
B	Antenna with right angle adapter	1
C	Removable terminal blocks	2
--	Power supply and plug adapter kit (optional)	1 each
E	Node Tester Board (optional)	1
--	User Manual, Quick Start Guide and Calibration Certificate	1 each

Table 1 - V-Link® -LXRS® Components List

3. Basic Setup and Operation

⚠WARNING

The V-Link® -LXRS® Wireless Sensor Node contains an internal, rechargeable Lithium Polymer (Li-Po) battery. See "Safety Information" on page 72 for important precautions.

To acquire sensor data, the V-Link® -LXRS® is used with any LORD MicroStrain® data gateway, such as the WSDA® -Base or WSDA® -1000, and a software interface.

LORD MicroStrain® has two software programs available for the Wireless Sensor Network, SensorCloud™ and Node Commander®. SensorCloud™ is a web based data collection, visualization, analytical and remote management platform based on cloud computing technology. SensorCloud™ provides the most complete functionality. The Node Commander® software package is also fully featured, and includes all functions needed for sensor configuration and data acquisition. Node Commander® is included with all data gateways, and is sufficient for the basic operations explained in this guide.

In this section hardware and software setup is described, including an overview of the Node Commander® software menus required to configure a sensor connected to the V-Link® -LXRS® , and begin data acquisition. It is intended only as a quick start guide for the node and is not a complete demonstration of the software features.

- For an example sensor configuration and calibration routine, or for verification of system functionality, see "Using the Node Tester Board" on page 49.
- For instructions on connecting specific sensors, see "Connecting Sensors" on page 21.

NOTE

To maximize operating time, it is recommended that the V-Link® -LXRS® internal battery be charged fully before installation. If fully discharged, it takes approximately 6 to 8 hours to achieve a full charge. See "Charging the Node Battery" on page 42 for charging instructions.

3.1 Interface and Indicators

The V-Link® -LXRS® interfaces include 1) a power input jack for charging the internal battery, or externally powering the node 2) a power on/off switch 3) terminal blocks for connecting sensing devices and 4) an antenna connector for attaching the node antenna.

The indicators on the V-Link® -LXRS® include 1) a device status indicator and 2) a battery charge status indicator. The following table describes basic indicator behavior. During data acquisition, the device status indicator has other advanced behaviors. See "Device Status Indicators" on page 48

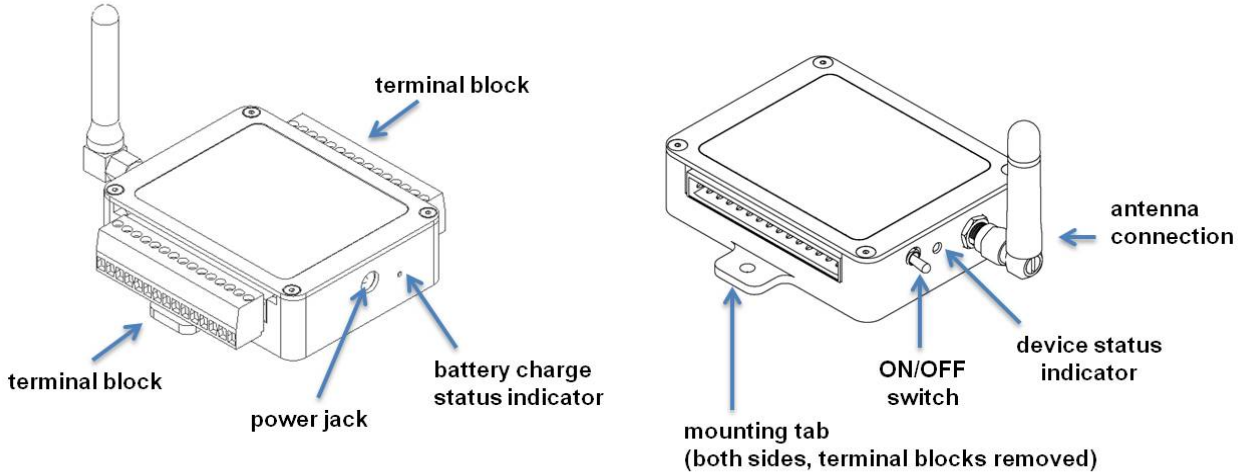


Figure 3 - Interface and Indicators

Indicator	Behavior	Node Status
Battery Charge Status Indicator	OFF	Node battery is not currently being charged
	ON bright red	Node battery is charging
	ON dim red	Battery fault condition, reset by unplugging power and then plugging it back in
	ON green	Battery is fully charged
Device Status Indicator	OFF	Node is OFF
	Rapid flashing	Node is booting up
	1 second pulse (approximate)	Node is in normal operational mode

Table 2 - Indicator Behaviors

3.2 Software Installation

To install Node Commander® on the host computer, complete the following steps.

1. Insert the CD in the host computer.

2. Follow the on-screen prompts.

NOTE

The Node Commander® software includes hardware drivers required for use with USB gateways. Once installed, the software will automatically detect and configure any USB gateways that are plugged into the host computer.

3.3 System Connections

To acquire sensor data the V-Link® -LXRS® is used with any LORD MicroStrain® data gateway, such as the WSDA® -Base and WSDA® -1000. Although the node will communicate with any gateway, the communication protocols between the gateway and host computer vary depending on which model is used. The WSDA® -Base gateways utilize local serial connections to the host computer, such as RS232 and USB. The WSDA® -1000 gateway utilizes Ethernet communications. The following instructions describe how to connect the hardware components.

1. Connect the data gateway to the host computer with the communications cable applicable to the gateway being used.

    a. For RS232 applications, a USB to RS232 adapter may be used with a computer that does not have a serial port.

    b. For USB applications, drivers need to be installed on the host computer. These drivers are included with the Node Commander® software. If the USB gateway is plugged into the host computer prior to the software being installed, simply unplug it and then plug it back in, after software installation, for automatic discovery.

c. For Ethernet applications, connecting the gateway to a DHCP enabled network is the simplest way to establish communication. If no DHCP network is available, or communication cannot be established, host network configuration may be required to establish communication.

2. Plug the gateway power supply into the gateway and into a 120/240VAC, 50/60Hz AC power source using the country adapters supplied, if needed. USB gateways are powered from the computer and do not require an external power source.

3. Connect the sensor to the node terminal block, or remove the terminal block and install the Node Tester board. See "Connecting Sensors" on page 21 for sensor connection details or see "Using the Node Tester Board" on page 49 for tester board connection details. An abbreviated pin diagram is included in the following figure for the connections to differential input channel 1.

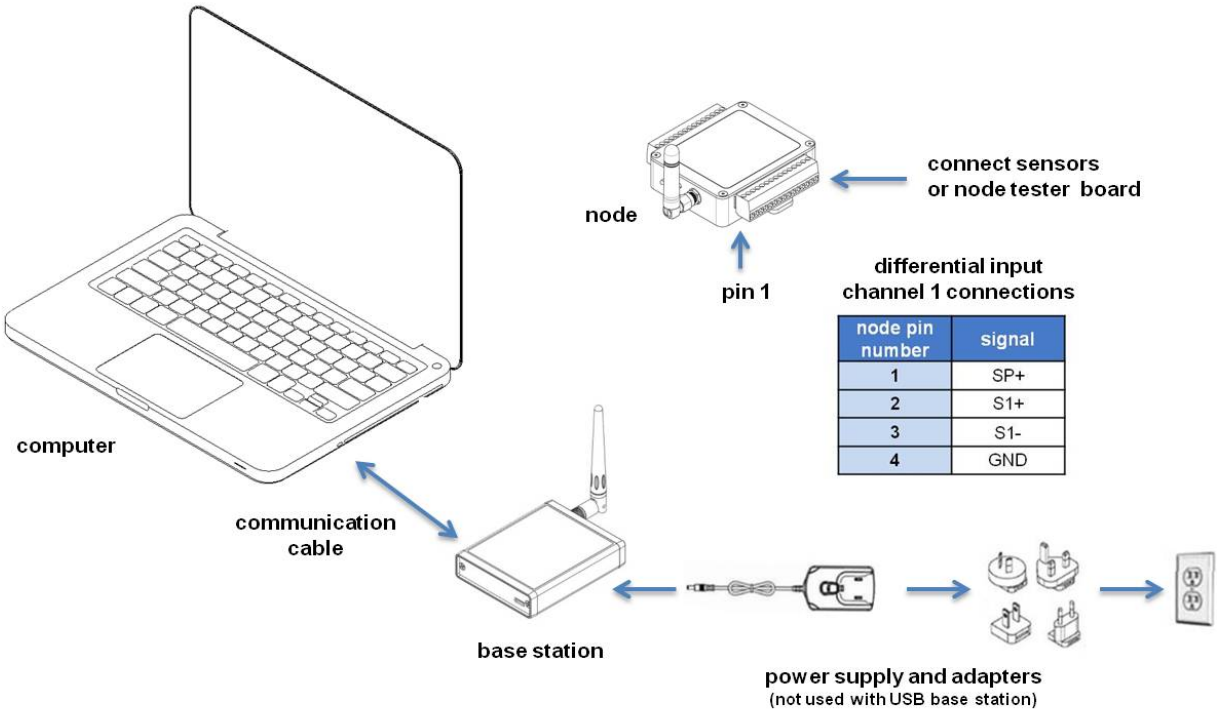


Figure 4 - System Connections

3.4 Node Communication

NOTE

Nodes can be configured with the Node Commander® software to boot up in different modes, depending on the application. This section describes how to establish communication in the normal boot mode. When the node is set for normal boot mode, the device status indicator will flash rapidly, and then pulse in one second intervals thereafter when powered on. If any other indicator behavior is observed, the node may be configured for a different mode. See "Device Status Indicators" on page 48 for more information. If the node is in another boot mode, it can be bypassed by toggling the node ON/OFF switch rapidly three times, then leaving it in the ON position for normal power up.

1. Open the Node Commander® software

2. Power on the data gateway

3. With the gateway plugged into the host computer, communication should be established automatically. In the Main window of Node Commander® a list of attached gateways will populate in the left window.

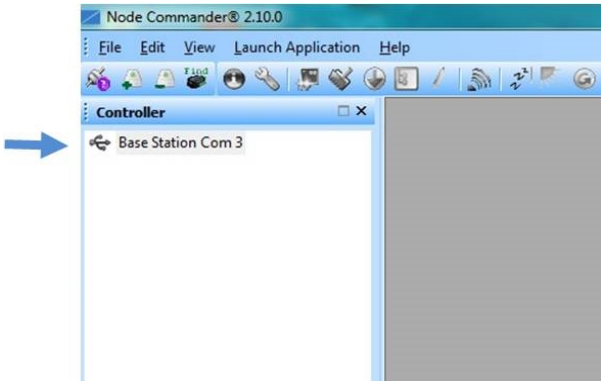


Figure 5 - Node Commander® Main Window

4. Right click on the Base Station Com X heading and select Add Node, Node Discovery.

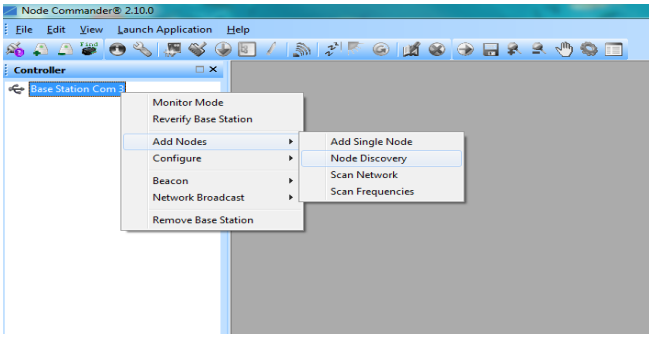


Figure 6 - Adding a Node in Node Commander®

5. As the gateway listens for available nodes, turn the V-Link® -LXRS® node ON with the ON/OFF switch. During power up the node will transmit a message with its operating frequency. This will occur within a few seconds.

6. When the device status indicator on the node ends the rapid flash sequence and begins pulsing at one second intervals, it has completed the power on sequence and is running in the normal operating mode. At this point scanning can be stopped by selecting the Stop button in the Node Discovery window. Verify the node is listed under the Base Station. Additional node information can be viewed by selecting the "+" symbol next to the node heading.

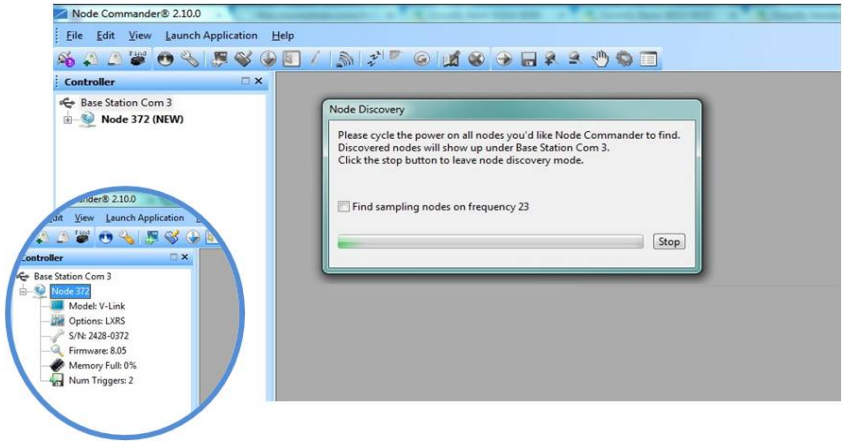

Node Commander® 2.10.0
File Edit View Launch Application Help
Controller
Base Station Com 3
Node 372 (NEW)
Node Discovery
Please cycle the power on all nodes you'd like Node Commander to find.
Discovered nodes will show up under Base Station Com 3.
Click the stop button to leave node discovery mode.
Find sampling nodes on frequency 23
Stop
Model: V-Link
Options: LXRS
S/N: 2428-0372
Firmware: 8.05
Memory Full: 0%
Num Triggers: 2

Figure 7 - Node Discovery

3.5 Channel Configuration

The node needs to be configured for the sensor that is connected to it. Below are the steps required to enter the channel configuration menus, and provides an overview of menus and configuration options. For an example configuration using the Node Tester board, See "Using the Node Tester Board" on page 49.

1. Right click on the Node heading and select Configure, Configure Node.

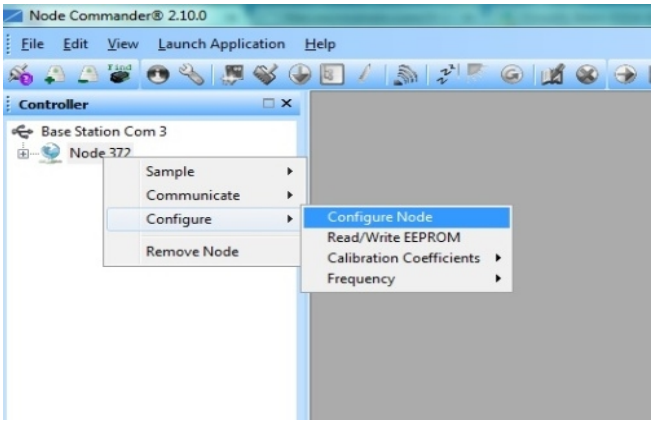


Figure 8 - Node Configuration

2. Select the check box to enable the channel the sensor or test board is connected to, and then select Configure.

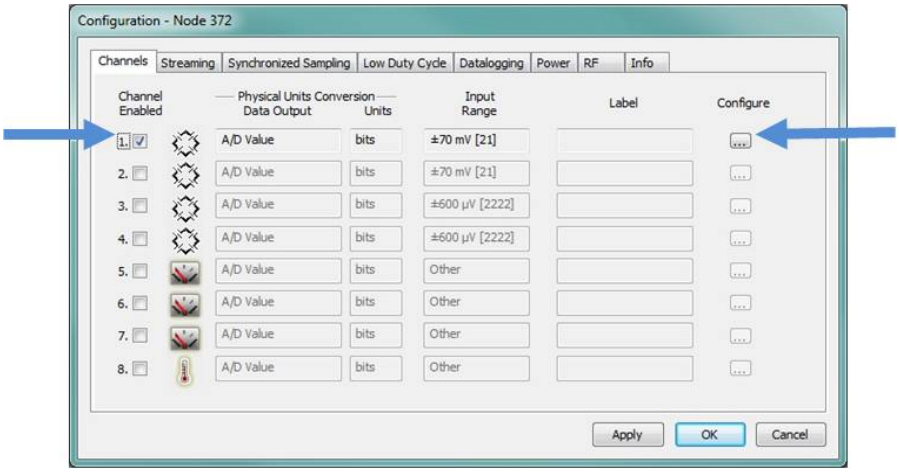


Figure 9 - Node Channels Menu

3. Select the desired channel configuration options. Below is a description of some of the primary settings

   a. **Conversion Coefficients:** defines the type and units of the measurement being made.

   b. **PGA Settings, Input Range:** is the sensor signal range. This setting determines what gain is applied to the sensor measurement and is only available for some sensor types.

   c. **PGA Setting Auto Balance:** sets the position of the no load baseline measurement for the sensor signal. Low is for positive output signals, High is for negative output signals, and Mid-range is for and positive and negative going output signals. Once the scale level is selected, the Auto Balance procedure is used to sets the no load baseline of the sensor at the designated scale level. This feature is only available for some sensor types.

   d. **Slope and Offset:** are the calibration values for the sensor. They can be entered manually or, for some sensors, calibrated using a calibration wizard. See "Sensor Calibration Methods" on page 13 for more information about calibration options.

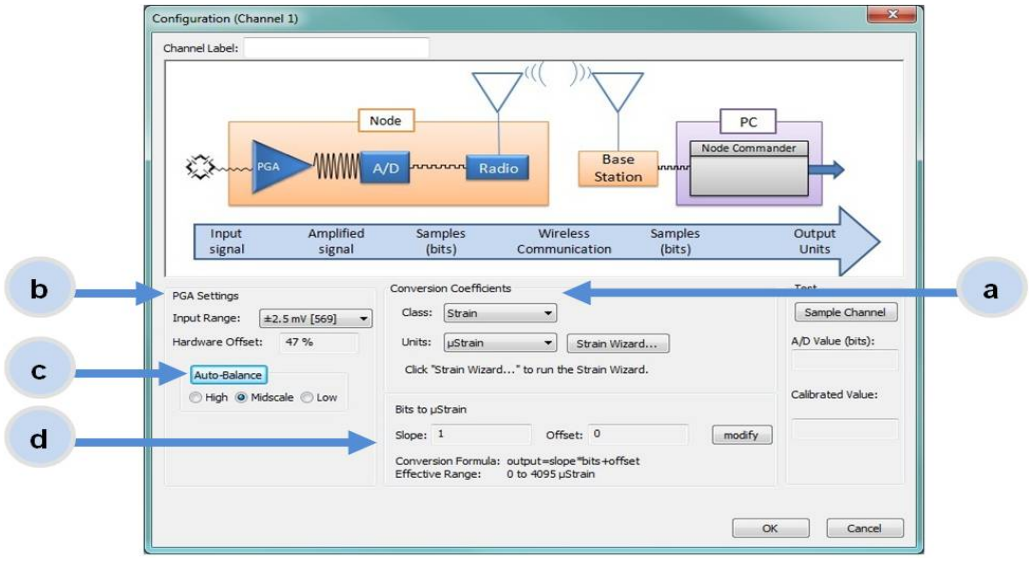


Figure 10 - Channel Setup

4. Once configurations settings have been entered for the sensor or Node Tester board, select OK to exit the Channel Configuration window.

5. Back in the Node Configuration window; select Apply to write the configuration and calibration values to the node memory.

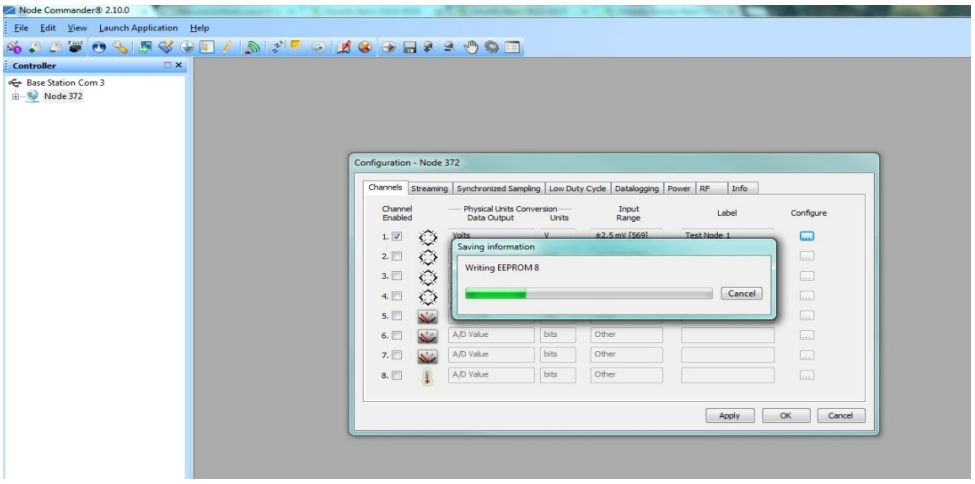


Figure 11 - Apply Node Settings

3.6 Sensor Calibration Methods

Many sensors require calibration in order to provide accurate data measurement. Calibration accounts for differences between individual sensors and systemic variables. Methods for determining the calibration values depend on the type of sensor measurement and application. The Node Commander® software facilitates multiple calibration methods, and are described below. The calibration values are applied when the software converts the raw voltage output of the sensors into the units designated during channel configuration.

- **Sensor manufacturer's calibration:** The slope and offset values, or some derivation, are provided with the sensor by the manufacturer to prove its accuracy and describe expected voltage output. Depending on the units, these values may be directly entered into the channel configuration menu, or may require calculations first.

Sensor wiring, tolerances in system electronics, and differences in mounting techniques are examples of systemic variables that can influence the sensor readings. Sensors that are making small measurements or are otherwise sensitive to these slight differences may benefit from a system calibration. The following techniques are system calibrations.

- **System shunt calibration (internal and external):** This option is only available for Wheatstone bridge type sensors, such as strain gauges, and utilizes a calibration wizard in Node Commander®. In the shunt calibration process, an internal or external precision resistor is used to load part of the sensor bridge while the sensor remains unloaded. The bridge output is measured and used as a loaded calibration point for the sensor. In addition to the zero load value it can be used to derive the calibration slope and offset. The internal shunt resistor is suitable for most applications, however an external shunt may be beneficial in high gain scenarios. For more information on the Wheatstone bridge configurations and sensor gain settings see "Differential Sensors" on page 29. For a demonstration of the Strain Wizard calibration process, see "Using the Node Tester Board" on page 49

- **System field calibration:** An alternate to the shunt calibration is to apply a known load to the sensor and measure the output. With two or more data points, the known value can be plotted against the measured output and used to determine the calibration slope and offset. In Node Commander® this can be accomplished by taking sensors readings (sampling) while applying known loads.

3.7 Data Acquisition

The V-Link® -LXRS® is capable sampling in many different sampling modes, and at various sampling rates. See "Operating Specifications" on page 68 for a complete list of available sampling modes and data logging capacity.

In general, when determining what sample mode and rate is most suitable for the application, consider the following;

- Increasing the sample rate reduces the system bandwidth, and therefore the number of nodes that can be reporting simultaneously.
- Increasing the sample rate increases the duration the node is on over time, and therefore reduces battery life.
- Some sampling modes, such as Streaming which is continuously recording data, will use more bandwidth and battery power than fixed interval or event based polling modes such as Low Duty Cycle and Event Triggered.

NOTE

Touching connected sensors and test boards, or charging the node battery while acquiring sensor data may induce noise on sensitive sensor signals and is not recommended.

The following is an example of Synchronized Sampling.

1. Right click on the Node heading and then Sample, Synchronized Sampling.

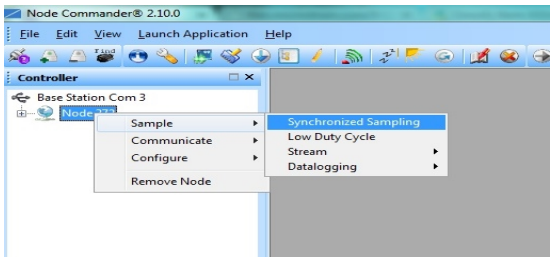


Figure 12 - Node Sampling Menu

2. In the Synchronized Sampling window, select the destination folder for the data in the Save Location field, as shown in Figure 13 - Node Sampling Settings.

3. Select Apply Network Configuration, and then select Start Sampling.

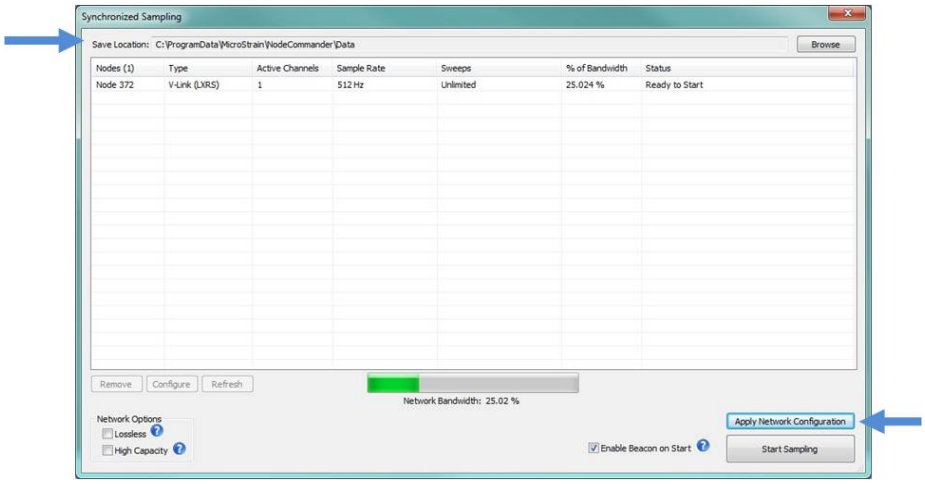


Figure 13 - Node Sampling Settings

4. Close the Settings window with the window X in the upper right to view the Sampling window behind it. This is the Data Grid view. Use the "+" symbol next to the node heading to view the data statistics.

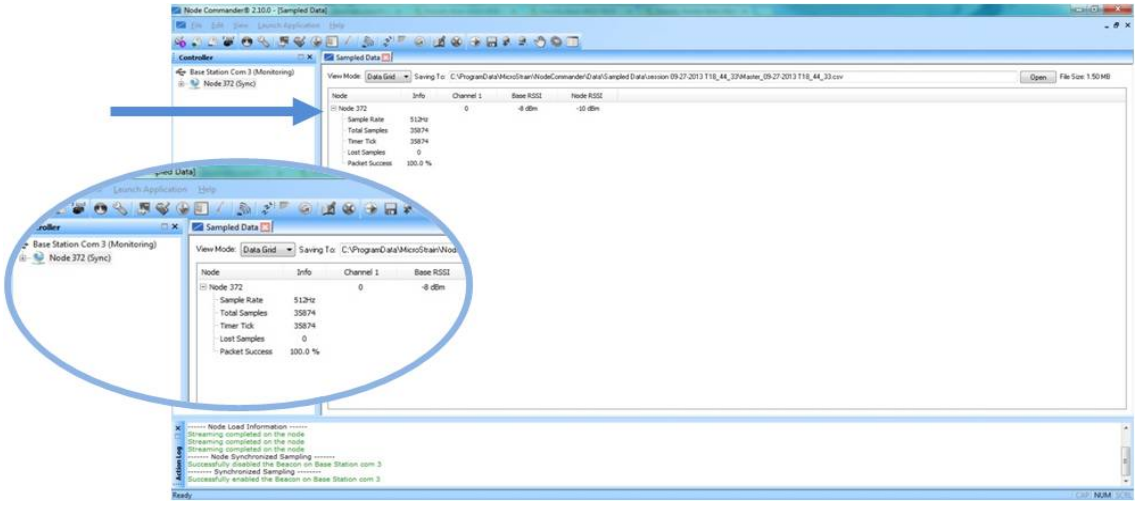


Figure 14 - Sampling Data Grid View

5. Select Graph from the View Mode field, and then click on the Node header to view a graphical representation of the data.

6. To end sampling, close the Sampled Data window with the red and white X on the window tab, and select Exit, Stop Nodes to stop sampling.

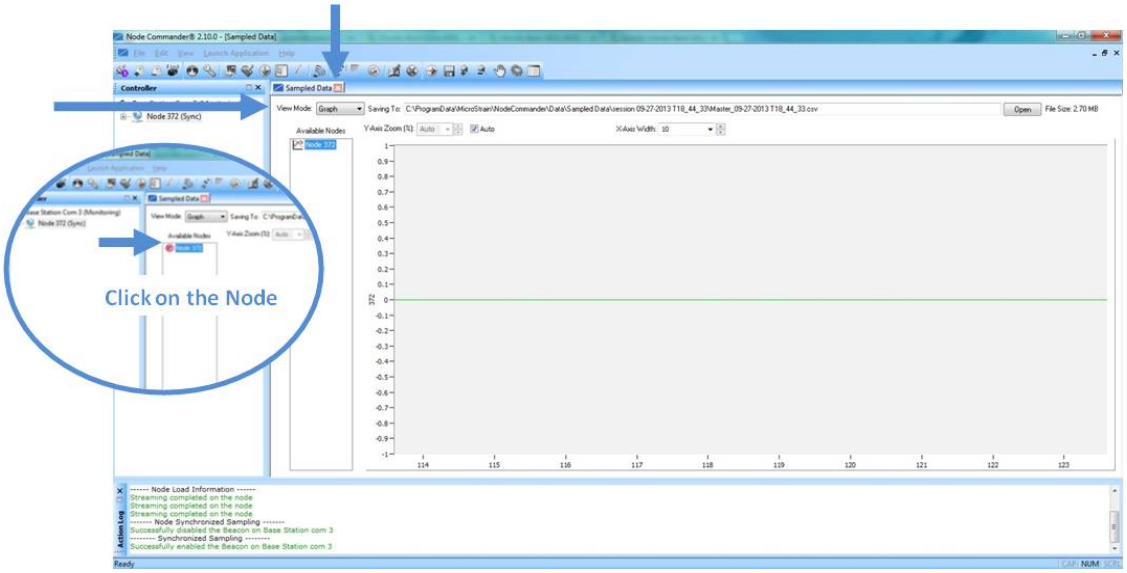


Figure 15 - Sampling Data Graph View

3.8 Viewing Sensor Data

Data is stored in CSV format and can be viewed with Microsoft Excel, Quattro Pro, Open Office and other CSV editors and spreadsheet programs. The files can be found in the location specified at the beginning of sampling, through the Node Commander® File menu. Different sampling modes will output different file types. Synchronized sampling will produce four files; the Master data file, the Node file, Sensor settings file and the sensor Networks file.

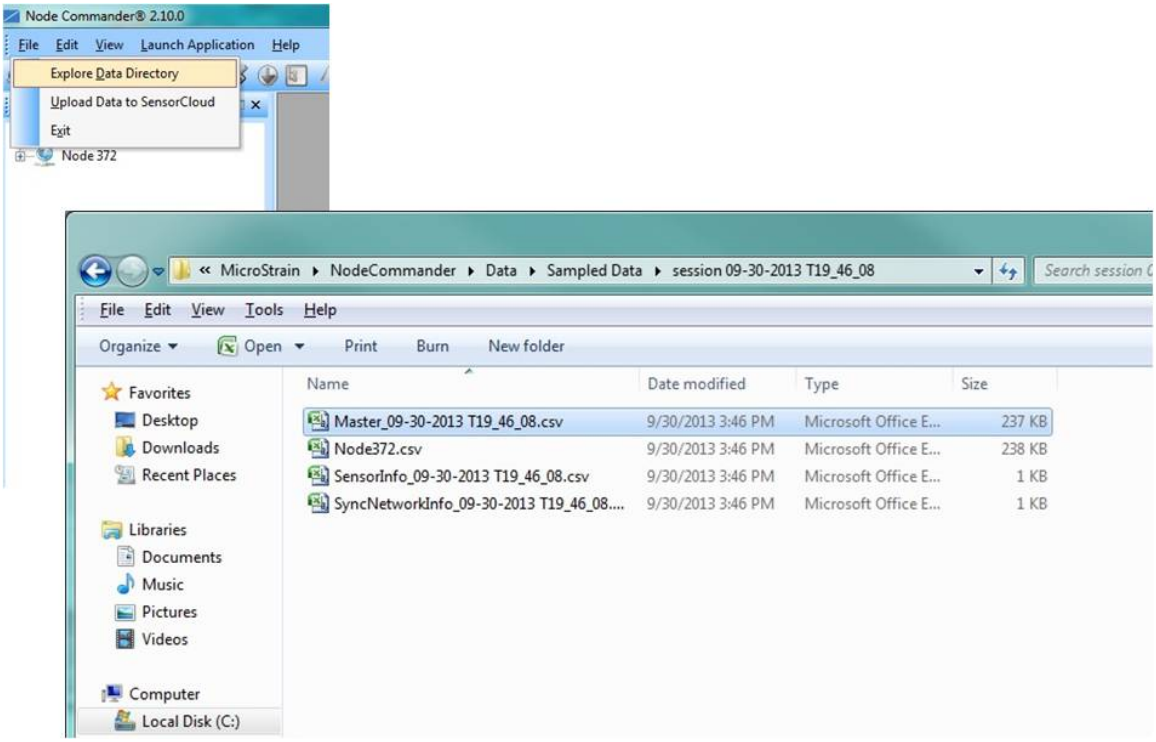

Node Commander® 2.10.0
File Edit View Launch Application Help
Explore Data Directory
Upload Data to SensorCloud
Exit
Node 372
« MicroStrain ▸ NodeCommander ▸ Data ▸ Sampled Data ▸ session 09-30-2013 T19_46_08
File Edit View Tools Help
Organize Open Print Burn New folder
Favorites
Desktop
Downloads
Recent Places
Libraries
Documents
Music
Pictures
Videos
Computer
Local Disk (C:)
Name Date modified Type Size
Master_09-30-2013 T19_46_08.csv 9/30/2013 3:46 PM Microsoft Office E... 237 KB
Node372.csv 9/30/2013 3:46 PM Microsoft Office E... 238 KB
SensorInfo_09-30-2013 T19_46_08.csv 9/30/2013 3:46 PM Microsoft Office E... 1 KB
SyncNetworkInfo_09-30-2013 T19_46_08.... 9/30/2013 3:46 PM Microsoft Office E... 1 KB

Figure 16 - Exploring Data

4. Node Installation

4.1 Mounting Recommendations

The V-Link® -LXRS® is rated for indoor use only, unless used with the ruggedized outdoor housing. The housing also accommodates two D cell batteries, extending the battery operating capacity and duration of the node. See "Node Accessories " on page 63 for more information.

The node has two mounting tabs with holes for fastening. The terminal blocks must be removed to insert the mounting hardware. The node can be mounted in any orientation but it is recommended that it is mounted in a way that optimizes the wireless communications, typically with the antenna pointing upward. See "Optimizing the Radio Link" on page 19 for more information.

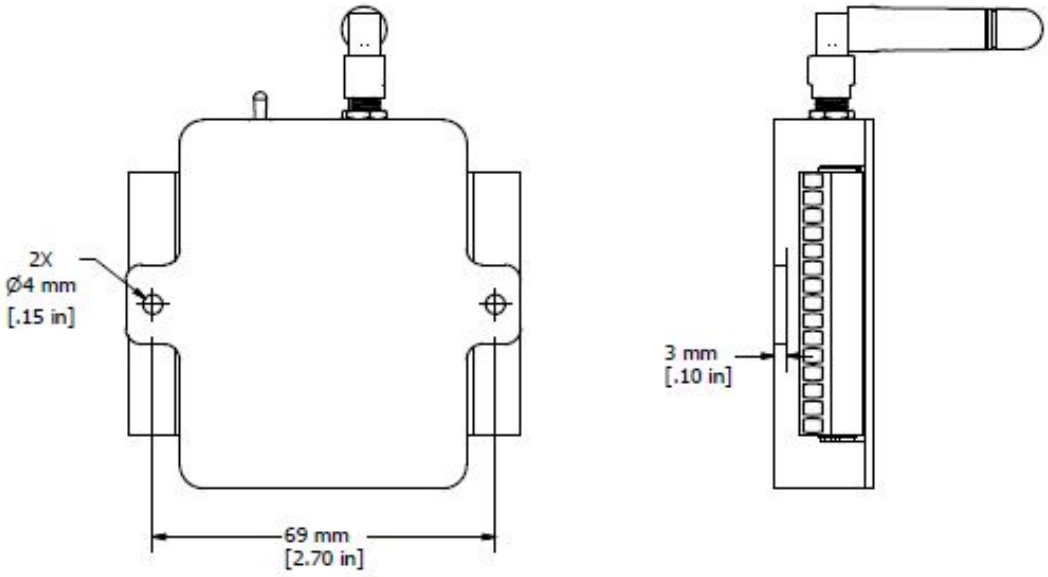


Figure 17 - Mounting the Node

4.2 Optimizing the Radio Link

In ideal conditions, the nodes and gateway can communicate up to two kilometers apart. In order to accomplish this, the node must be installed in a manner that optimizes the wireless transmission. The V-Link® -LXRS® operates at a 2.4GHz transmission frequency, and comes standard with a right-angle, ¼ wave rubber whip antenna with a with an omni-directional radiation pattern. The antenna has a joint in the middle that allows it to be rotated and aimed. Using any other antenna than what is included with the node will void FCC compliance.

The best method for ensuring optimal radio communication is to conduct an RF survey of the installation site. This is easily accomplished in Node Commander® by using the range test feature to quantify the radio signal strength (RSSI) in various scenarios. The following bullets are general guidelines for maximizing transmission range. See "Range Test" on page 20 for instructions on using Node Commander® for measuring RSSI.

- **Establish Line of Sight (LOS)** between the node and gateway antennas as best as possible. Minimize the obstructions between them such as, buildings, terrain, vegetation (in all seasons) or other physical barriers. Increase the mounting height of the node or antenna if it allows a clearer LOS path to the gateway.

- **Minimize Radio Frequency Interference (RFI)** such as other equipment antennas, especially those operating in the same frequency range. This includes other nodes. If other antennas are required nearby, mount them at different heights to minimize interference. Additionally, the specific node frequency is selectable within its operational range using the Node Commander® software. Set the devices to different transmission frequencies.

- **Minimize Electromagnetic Interference (EMI)** such as that generated by power transmission equipment, microwaves, switching power supplies and other electromagnetic sources.

- **Avoid Metal Objects** in close proximity to the node antenna, especially ferrous metals such as steel and iron which can be problematic for wireless communications. The larger the object the greater the influence. If mounting on metal or near metal objects in unavoidable, the antenna can be mounted remotely with an antenna cable. The connector on the antenna is male reverse polarity SMA (male RPSMA), so a male to female RPSMA cable would be required.

4.2.1 Range Test

After establishing communication between node and gateway, use the range test in Node Commander® to monitor the signal strength and best position the node and antenna for installation.

1. Right click on the node header,and the select Communicate, Range Test.

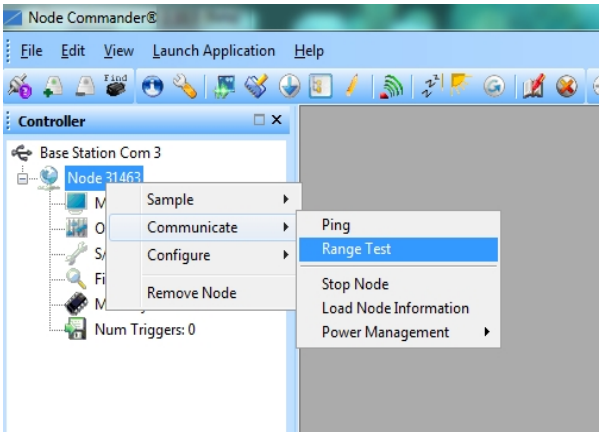


Figure 18 - Range Test Menu

2. The total RSSI range for the node and gateway is -90 to 0 dBm. The higher the value (closer to zero), the better, but reliable communication can be achieved between 0 and -75dBm. The devices may still communicate between -75 and -90dBm, but it could be intermittent or result is data loss. Position the node and antenna where the best RSSI value is observed.

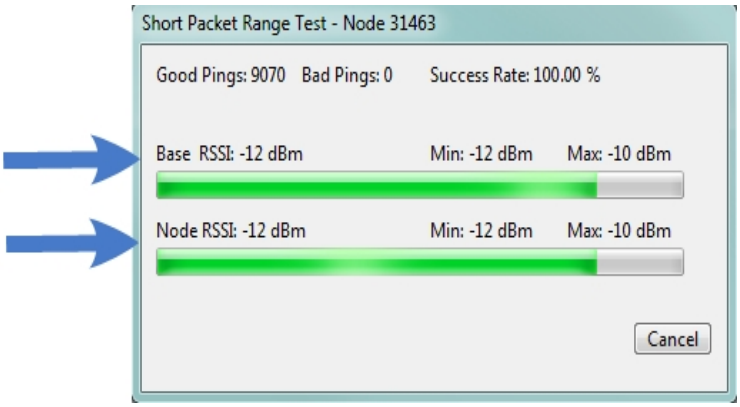

Short Packet Range Test - Node 31463
Good Pings: 9070 Bad Pings: 0 Success Rate: 100.00 %
Base RSSI: -12 dBm Min: -12 dBm Max: -10 dBm
Node RSSI: -12 dBm Min: -12 dBm Max: -10 dBm
Cancel

Figure 19 - Range Test Statistics

5. Connecting Sensors

⚠WARNING

The V-Link® -LXRS® Wireless Sensor Node contains an internal, rechargeable Lithium Polymer (Li-Po) battery. See "Safety Information" on page 72 for important precautions.

The V-Link® -LXRS® wireless sensor node features seven analog input channels that interface with a wide range of available sensors technologies, essentially converting them into wireless sensors. The node accommodates Wheatstone Bridge and analog sensors for applications in wireless strain gauge monitoring, such as torque, force and pressure measurement, as well as sensors for other applications like wireless accelerometers, vibration sensors, magnetic field and displacement sensors. Environmental sensing can be achieved with wireless RTD and wireless thermocouple monitoring.

The V-Link® -LXRS® includes three channels for single ended sensor measurement, four channels for differential sensor measurement, and an additional channel dedicated to the on-board internal temperature sensor. Differential channels may need to be factory set to work for specific types of sensors. See "Differential Input Channels" on page 26 for information about channel configurations and see "Parts and Configurations" on page 62 for ordering information.

5.1 Sensor Requirements

Below are guidelines for selecting sensors for use with the V-Link® -LXRS® . For interfacing with sensors outside of these parameters, or not included in the examples in the following sections, contact Technical Support (see "Technical Support" on page 60).

Sensor Impedance:

- Differential input sensors for a standard V-Link® -LXRS® should have an impedance of either 350Ω or 1000Ω. Sensors that are 120Ω are not recommended. For half and quarter bridge configurations, the node impedance value is set to match the sensor when the node is manufactured, and must be specified at the time of order. See "Parts and Configurations" on page 62 for more information. Custom bridge completion impedance values are available on request.

- Single ended sensor inputs must have impedance that is less than 5KΩ.

Sensor Signal Voltage:

- The differential sensor inputs in the V-Link® -LXRS® Wireless Sensor Node include a hardware gain and offset stage before the sensor input signal is processed by the analog to digital voltage converter within the node. The combination of the gain, offset and sensor signal voltage cannot exceed the 0 to 3VDC input range of the analog to digital converter. For more information see "Differential Input Gain and Offset" on page 27.

- Single ended sensor signal voltages can only be positive voltages, with respect to the system ground, and must be between 0 and 3VDC. For single ended sensor signal voltages outside of that range see "Measuring Voltages over Three Volts" on page 34

Sensor Power:

- When using the internal node battery as the node power source, the total current use for all connected sensors must be less than 50mA. If more current is required, a higher capacity external power source can be used for the node or the sensor. See "Sensor Power" on page 23 for information about sensor power requirement considerations and options, and see "Powering the Node" on page 39 for information regrading node power options.

5.2 Wiring Recommendations

In is good practice that all sensor wiring be done with shielded cable. The shield is connected to the system ground at one end only to avoid ground loops. For sensitive small voltage signals, such as strain gauges, sensor wire leads should be of matched lengths so the lead resistance for each connection is as close to each other as possible. For long lengths of wire, a system calibration is recommended over a sensor calibration. See "Sensor Calibration Methods" on page 13.

5.3 Sensor Power

⚠CAUTION

When using the internal node battery to power the node, total sensor current draw of over 50mA can cause permanent damage to the node and should be avoided.

Sensors can be powered by the node or with an external power supply. The node sensor excitation voltage is 3VDC and can provide up to 50mA total on all channels. If a higher voltage or more current is required for the sensor, an appropriately sized external power supply can be used. For example, using the node battery for current intensive devices such as 4 to 20mA sensors will drain the battery quickly. For these applications, an external source is recommended for the sensor or the node. See "0 to 3VDC Voltage Measurements" on page 33 for an example of using an external source for the sensor, and see "Powering the Node" on page 39 for node power information.

Drain on the battery can also be limited by selecting low resource sampling modes and low duty sampling rates, which automatically switches the node excitation voltage off after sampling. This feature can also be utilized to turn switches on and off to further control resource use. See "Using the Excitation Output as a Switch" on page 36 for more information.

External battery holders and a ruggedized outdoor housing that accommodates two D cell batteries are available for the V-Link® -LXRS® , and can be used to extend battery operating capacity and duration. See "Node Accessories " on page 63.

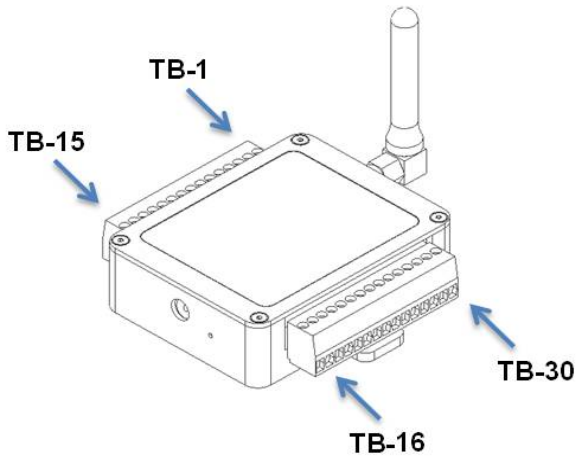
5.4 Node Channels Designations

Channel	Description	Pin Nomenclature
1	differential channel 1	S1
2	differential channel 2	S2
3	differential channel 3	S3
4	differential channel 4	S4
5	single ended channel 1	Ain1
6	single ended channel 2	Ain2
7	single ended channel 3	Ain3
8	on-board temperature sensor channel	--

Table 1 - Channel Designations

5.5 Terminal Block Connections

When inserting the sensor leads into the terminal block ensure the lead wire is being clamped under the terminal screw and not the lead insulation. If the sensor wires are a very fine gauge, folding and tinning them may be useful to provide more area for the terminal screw to make contact. Failure to provide adequate connection may result in erroneous data.



Node Pin Number	Signal	Node Pin Number	Signal
1	SP+	**16**	SP+
2	S1+	**17**	S4+
3	S1-	**18**	S4-
4	GND	**19**	GND
5	S1 S	**20**	S4 S
6	SP+	**21**	Ain5
7	S2+	**22**	GND
8	S2-	**23**	Ain6
9	GND	**24**	GND
10	S2 S	**25**	Ain7
11	SP+	**26**	GND
12	S3+	**27**	NC
13	S3-	**28**	NC
14	GND	**29**	GND
15	S3 S	**30**	Vin

Table 3 - Terminal Block Connections

5.6 Pin Descriptions

Signal	Description	Pin Type	Range
Vin	Node external power supply connection. An alternate to the node power jack. See "Powering the Node" on page 39 for details.	power input	+3.6 to +9VDC sufficient current capacity for all sensors connected
GND	Node power and sensor excitation return	power return	return
S+	Sensor excitation. Power to external sensors. At sampling rates under 32Hz, it is only active when the node is sampling the sensors.	output	+3VDC maximum combined load on all excitation pins is 50mA.
Sx+	Differential sensor input +. Positive input to the node programmable gain amplifier (PGA). Used with Sx-.	input	0 to +3VDC including gain and offset settings. Wheatstone Bridge compatible sensor with 350Ω or 1000Ω input impedance recommended
Sx-	Differential sensor input +. Negative input to the node programmable gain amplifier (PGA). Used with Sx+.		
Sx S	Input for three wire configuration of quarter bridge strain gauge bridges. Leave unconnected for non quarter strain gauge bridge applications.	input	0 to +3VDC including gain and offset settings. Wheatstone Bridge compatible sensor with 350Ω or 1000Ω input impedance recommended
Ainx	Single ended sensor input. Routed directly to the node analog to digital (A/D) converter. Return is node GND.	input	0 to +3VDC Less than 5KΩ
NC	Not connected	--	--

"x" denotes the channel number

Table 4 - Node Pin Descriptions

5.7 Differential Input Channels

NOTE

Differential channels are configured at the time of manufacture with optional Wheatstone Bridge configurations and impedance values, and must be connected accordingly. See "Parts and Configurations" on page 62 for options.

The differential channels provide an input for sensors with a separate analog return. The measurements are taken with respect to the analog return, instead of the system ground, in order to provide better protection for small measurements from EMI, RFI and other sources of signal noise. The V-Link® -LXRS® has four differential input channels. The primary use of these channels is for strain gauges, pressure transducers, load cells and other devices that can utilize a Wheatstone Bridge configuration. The V-Link® -LXRS® is available in standard configurations for either full, half or quarter Wheatstone Bridge operation, at various impedances. See "Differential Sensors" on page 29. Custom configurations are also available. See "Parts and Configurations" on page 62 for configuration and ordering options.

The differential measurement channels provide a +3VDC excitation voltage to the sensor, and measures the resulting sensor signal output. The sensor signal goes through a programmable gain amplifier (PGA) and is then processed in the node by a 16-bit analog to digital (A/D) converter, over the 3VDC range. The resolution of the sensor measurement is dependent on the operating range of the sensor. If the application is such that only a small portion of the 3VDC range is being utilized, better resolution can be achieved by increasing signal amplification and by zeroing the sensor baseline in the appropriate offset biasing range.

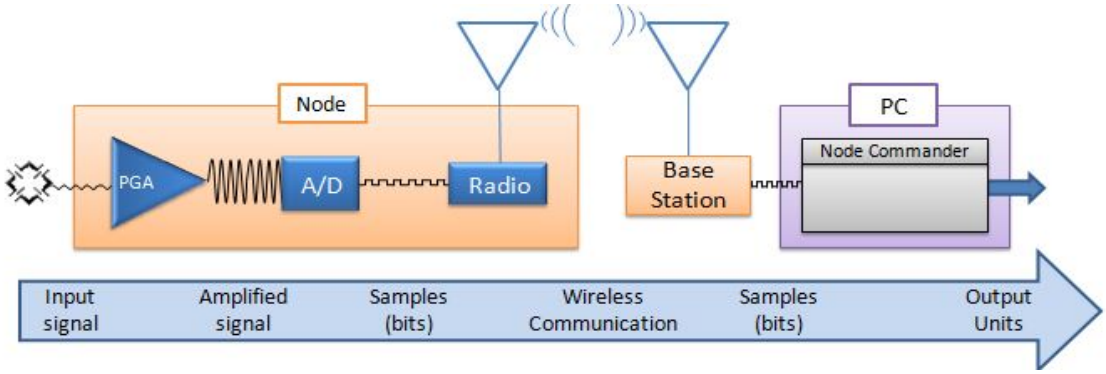


Figure 20 - Differential Channel Signal Processing

5.7.1 Differential Input Gain and Offset

The gain and offset range are set when the sensor channel is configured. The combination of the gain, offset and sensor signal cannot exceed the 0 to 3VDC input of the analog to digital converter within the node.

Table 5 - Differential Gain Value lists the gain settings available on the V-Link® -LXRS® differential input channels. The scaled input range is the approximate signal range of a sensor that would work with that gain, without considering the offset setting. To determine the gain and offset for a specific sensor consider the following bullets and examples.

- **Resolution:** Applying gain to the sensor signal can be used to maximize the measurement resolution. The more of the range that is used, the more digital counts are available to measure the signal, which typically means higher resolution measurements. Limitations to the gain adjustment are the 0 to 3V input range of the node, and the sensors measurement capabilities.

- **Offset:** The offset setting positions the zero load value of the connected sensor within the 0 to 3V range of the node input. A mid range setting positions the baseline offset in the middle of the 0 to 3V range (1.5V) and is used for sensors with negative and positive going signals. The low range setting positions the baseline offset in the bottom quarter of the 0 to 3V range (75mV) and is used for sensors with mostly positive going signals. The high range setting positions the baseline offset in the top 3/4 of the range and is used for mostly negative going signals.

Gain	Scaled input range
21	+/- 70mV
30	+/- 50mV
75	+/- 20mV
147	+/- 10mV
291	+/- 5mV
569	+/- 2.5mV
1214	+/- 1mV
2222	+/- 100uV
3799	+/- 100uV
13074	+/- 100uV

Table 5 - Differential Gain Value

EXAMPLE 1:

Sensor signal range: 0 to 50mV
Gain setting:: 21
Baseline offset range setting: Mid range

Calculations:

50mV * 21 = 1.05V (maximum voltage of sensor signal with gain)
1.05V + 1.5V = 2.55V (maximum input voltage to node with gain and offset)

Calculated node input over sensor range: 1.5 to 2.55V

This is a good setting because the node input voltage is within the 0 to 3V range

EXAMPLE 2:

Sensor signal range: 0 to 50mV
Gain setting::30
Baseline offset range setting: Low range

Calculations:

50mV * 30 = 1.5V (maximum voltage of sensor signal with gain)
1.5V + 75mV = 2.25V (maximum input voltage to node with gain and offset)

Calculated node input over sensor range: 75mV to 2.25V

This may be a better setting than in Example 1 because the gain is higher, which could increase the resolution of the measurement. The node input voltage is still within the 0 to 3V range.

EXAMPLE 3:

Sensor signal range: 0 to 50mV
Gain setting::75
Baseline offset range setting: Low range

Calculations:

50mV * 75 = 3.75V (maximum voltage of sensor signal with gain)
3.75V + 75mV = 4.5V (maximum input voltage to node with gain and offset)

Calculated node input over sensor range: 75mV to 4.5V

This setting will not work because the node input voltage is outside of the 0 to 3V range.

5.7.2 Differential Sensors

Sensors that are classified as differential sensors often utilize a Wheatstone Bridge configuration. These sensors are essentially a resistive load that use the bridge configuration to detect very small resistive changes and produce a precise voltage output as a result. Some examples include strain gauge elements or strain gauge based sensors, such as some load cells and pressure transducers, as well as some soil moisture, temperature and other sensors. For use with the V-Link® -LXRS® sensors with an impedance of 350Ω or 1000Ω are recommended.

Calibration in the Node Commander® software for these devices varies depending on the type of sensor, and includes using the a calibration wizard for strain gauges. The following diagrams show how to connect these types of sensors. See "Sensor Calibration Methods" on page 13 for more information.

KEY
x = channel number
R*x* = sensor element or resistor
S*x* = node terminal block connection
→ = variable output

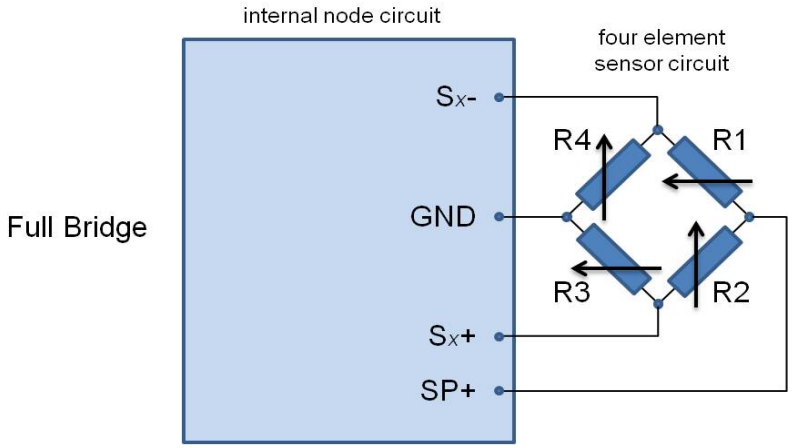


Figure 21 - Full Bridge Wiring

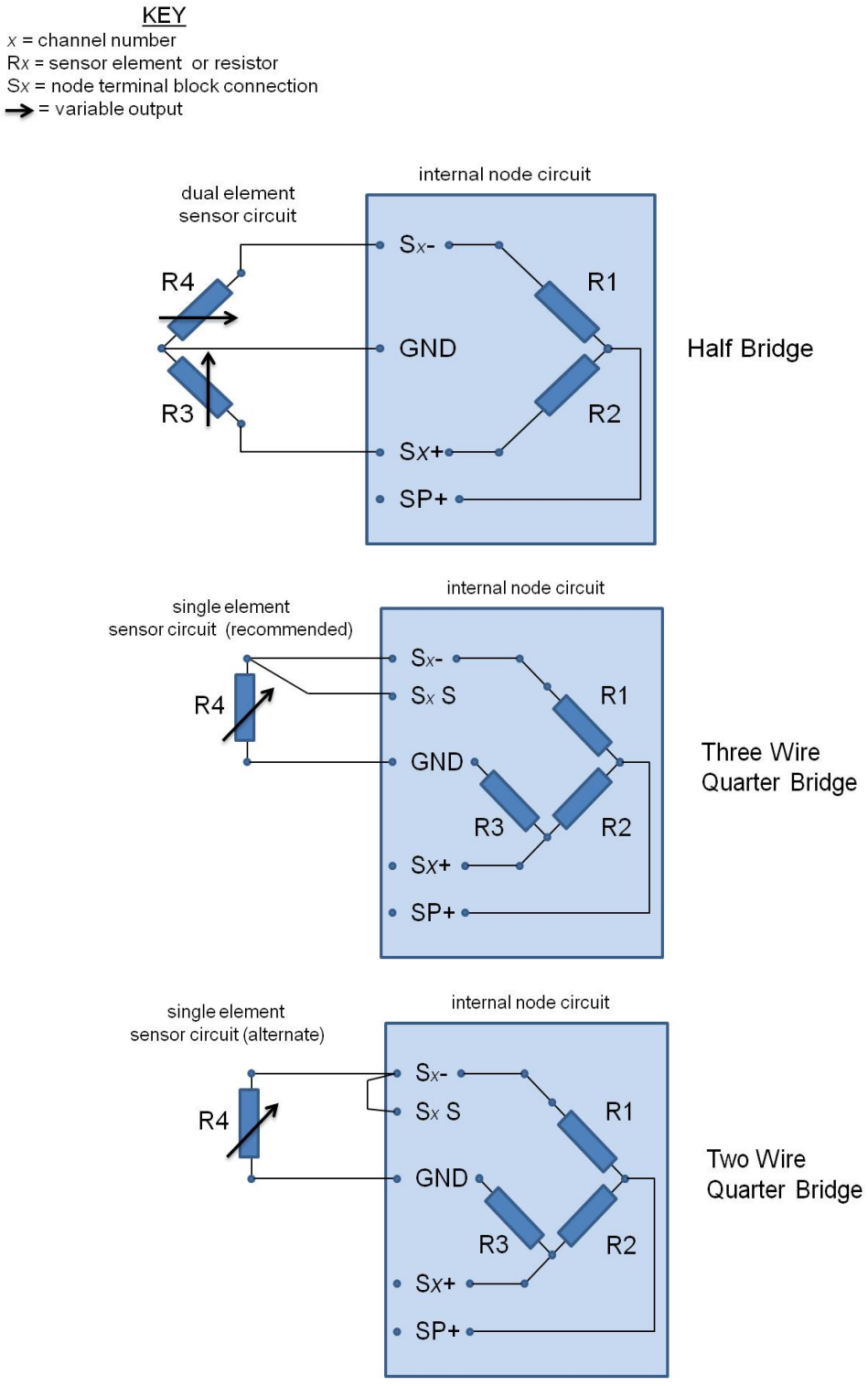


Figure 22 - Half and Quarter Bridge Wiring

5.7.3 Measuring Small Voltages

Some sensor types that have small signal voltages, around 20mV or less, may be better measured by biasing the sensor signal to the mid range of the node input range with a voltage divider, as shown in Figure 23 - Small Voltage Measurement.

Channel configuration will include adjusting the gain setting accordingly in the Node Commander® software.

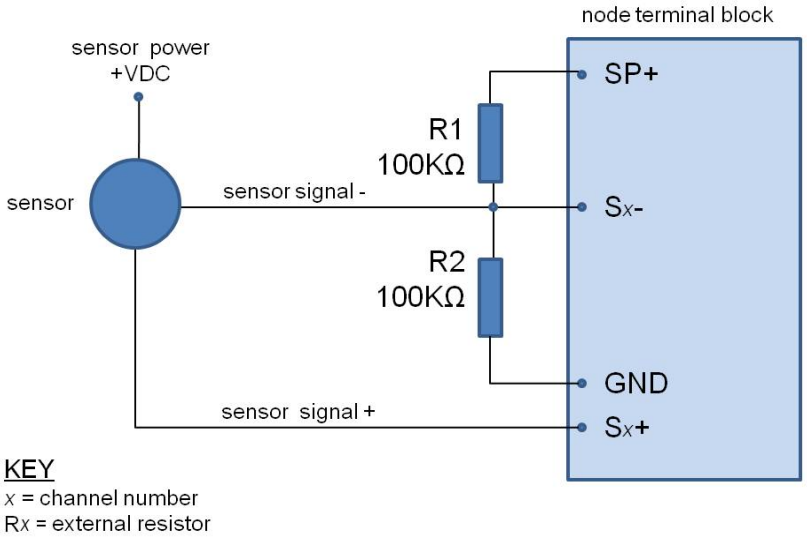


Figure 23 - Small Voltage Measurement

5.8 Single Ended Input Channels

The V-Link® -LXRS® has three single ended input channels. These channels are designed to measure voltages with reference to the system ground, and can accommodate many analog sensors types including accelerometers, pressure transducers, geophones, temperature sensors, inclinometers and more. These channels can also be used to measure reference voltages.

Sensors that operate on 3VDC can be powered with the node excitation voltage. Alternately sensors can be powered with an external source. See "0 to 3VDC Voltage Measurements" on page 33 for an example of how to connect an external supply.

The single ended channels can measure signals from 0 to +3VDC with reference to the system ground. Sensor output must be positive going voltage in order to operate correctly with the V-Link® -LXRS® . If the sensors output is greater than 3VDC a voltage divider can be used to decrease the scale. See "Measuring Voltages over Three Volts" on page 34. The impedance of the sensor must be less than 5KΩ.

The sensor output signal is processed in the node by a 16-bit analog to digital (A/D) converter, over the 3VDC range. The resolution of the sensor measurement is dependent on the full scale output range of the sensor. The closer it is to three volts, the more resolution will be achieved.

The following sections provide examples of how various sensors can be connected to the node. For other applications or those outside of the operating parameters listed above, contact Technical Support (see "Technical Support" on page 60 for contact information).

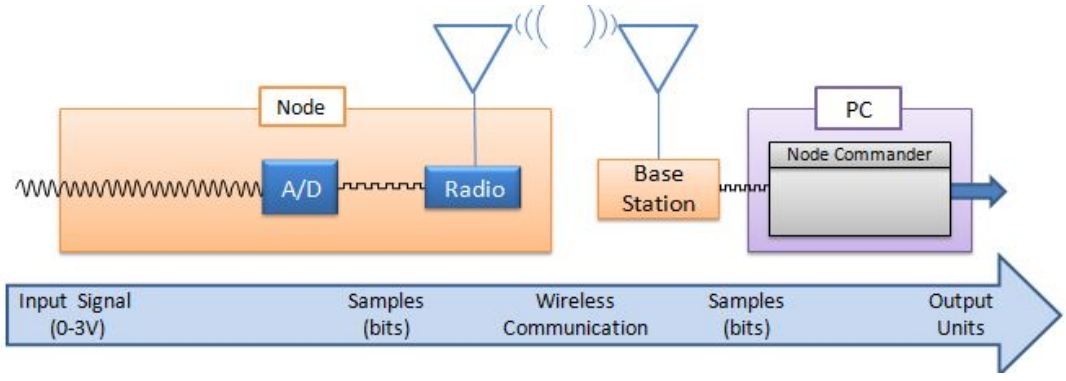


Figure 24 - Single Ended Signal Processing

5.8.1 0 to 3VDC Voltage Measurements

Sensors that operate in the 0 to 3VDC range are ideal for the node inputs. Resistive loads that are not differentially measured, such as string potentiometers, are easily measured by the node single ended channels. Power is provided by the node excitation voltage and measured on a single ended input, as shown below.

Reference power supply signals between 0 and 3VDC can be measured by connecting directly between the signal input pin (Ainx) and ground (GND).

Sensors that have voltage requirements outside of the range of the node excitation voltage can be powered externally with another source. The sensor output can still be connected directly to the node input as long as it is between 0 and 3VDC. For sensor outputs over 3VDC, see "Measuring Voltages over Three Volts" on page 34.

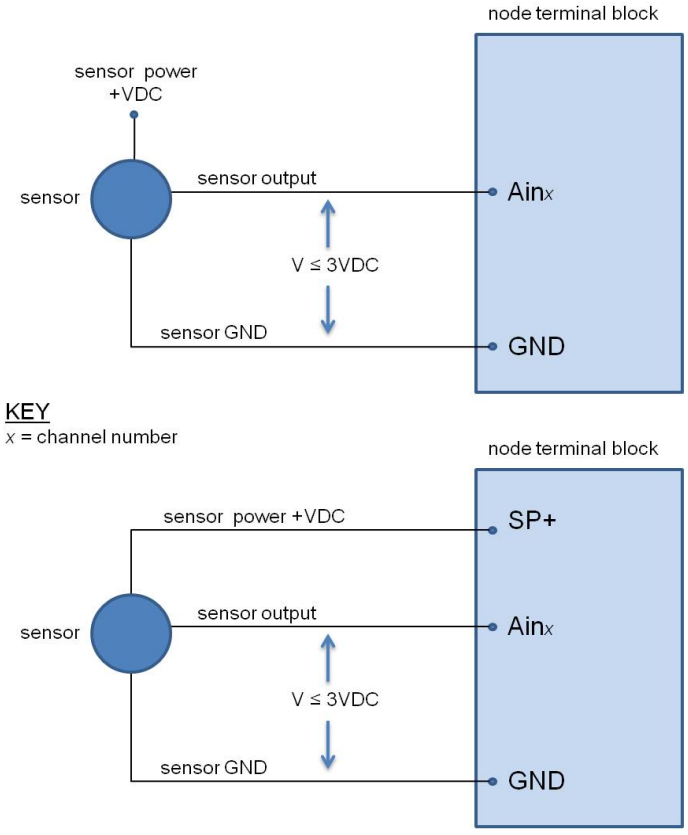
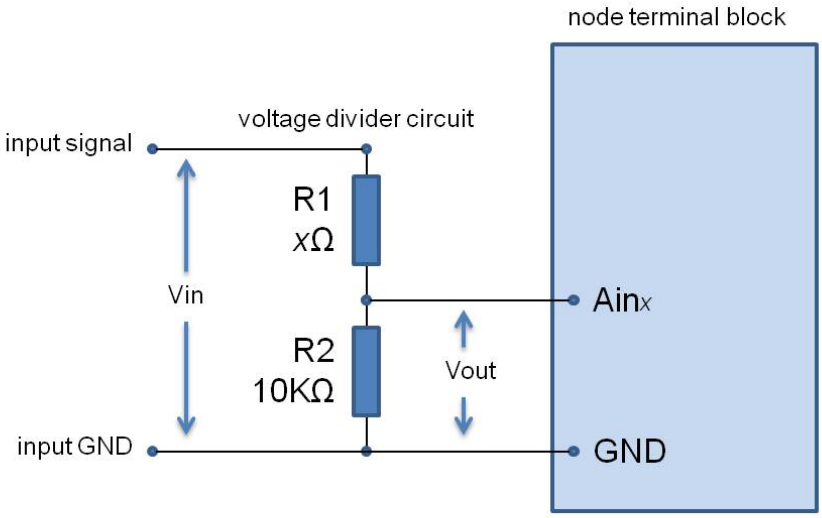


Figure 25 - 0 to 3VDC Measurements

5.8.2 Measuring Voltages over Three Volts

Voltages over three volts can be measured with the use of a voltage divider circuit. This may be necessary if a sensor is powered from an external source. The same circuit can also be used to measure reference power supplies over +3VDC.

The value of the voltages divider resistors will need to be determined, as required for the application. A 10KΩ resistor is recommended for the input to the node channel, leaving only one resistor to calculate, as shown in the example below



CALCULATIONS:

KEY
x = channel number
R*x* = external resistor

$Vin = \text{maximum sensor output}$

$Vout \leq 3$

$R2 = 10K\Omega$

by Ohms Law;

$$Vout = Vin\left[\frac{R2}{(R1+R2)}\right] \quad \text{or} \quad R1 = \left[\left(\frac{Vin * R2}{Vout}\right) - R2\right]$$

EXAMPLE:

$Vin = 0$ to 9VDC

$$R1 = \left[\left(\frac{9V * 10000\Omega}{3V}\right) - 10000\Omega\right] = 20K\Omega$$

5.8.3 Measuring Small Currents (4 to 20mA Sensors)

Sensors with small currents, such as 4 to 20mA sensors, can be used with the nodes by adding a precision sampling resistor across a single ended input channel to the node. Figure 26 - Small Current Measurements shows an example circuit.

Because the sensor output can be as much as 20mA it is recommended that an external source be used to power the sensor. When running on the internal node battery, the node excitation can only supply 50mA to all sensors, so 20mA would be a significant portion and would drain the battery quickly. See "Using the Internal Node Battery " on page 41 for battery life and current draw information. The current limitations can be mitigated by using an external power source for the sensor, or the node. If using node excitation power is the best for the application, drain on the battery life can be limited by only switching the node excitation voltage on just before sampling, and then turning it off afterward. This happens automatically at low duty sampling rates (32Hz or lower) and can be set up for other sample rates with external circuitry. See "Using the Excitation Output as a Switch" on page 36 for more information.

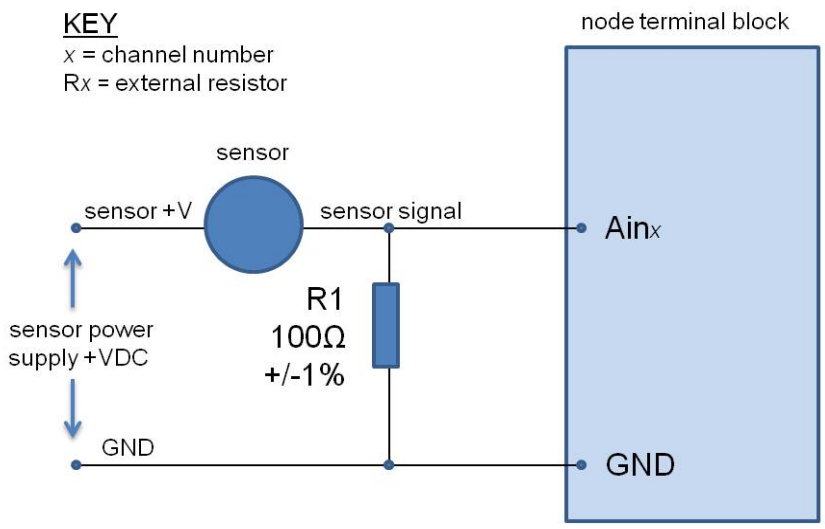


Figure 26 - Small Current Measurements

5.9 Using the Excitation Output as a Switch

At low sampling rates (under 32Hz) the node automatically switches the excitation voltage output off when the sensor is not being sampled, in order to conserve battery life. This feature can also be used in applications where a sensor switch is desired, such as when the sensor is powered by the internal node battery but has a large current draw. It can also be used simply as a switch, unrelated to the sensor, such as controlling a relay or transistor. The same limitations apply as to a sensor; the device must operate on 3VDC and not require more than 50mA when combined with all other sensor current draw. To use the excitation output in this way simply connect the control line of the device (example: relay coil or NPN transistor base) to the excitation pin on the node terminal block (SP+) and reference (example: other side of the relay coil or the NPN transistor emitter) to the node ground pin (GND).

5.10 Thermocouples

Thermocouples can be used on the differential input channels by simply adding a high impedance resistor to the input. Figure 27 - Connecting a Thermocouple shows an example circuit.

Thermocouples should be calibrated by first selecting the appropriate baseline offset range, output range, or gain, and then applying know loads and calculating the slope and offset values. Using water as the known load medium (submerging the thermocouple in ice and hot water baths) is a simple method that can be used for calibration.

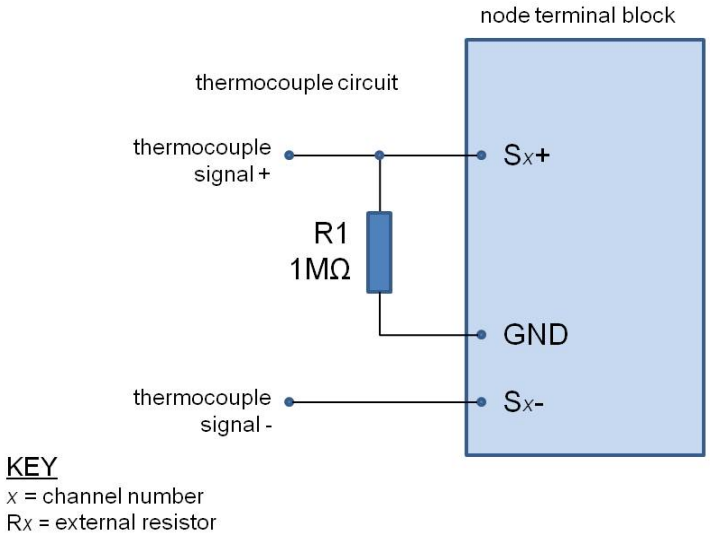


Figure 27 - Connecting a Thermocouple

5.11 Connecting Accelerometers

LORD MicroStrain® bridge type accelerometers, such as the Triaxial Accelerometer Cubes, can be used with V-Link® -LXRS® to create wireless acceleration sensor platforms. Connect each axis output to one of the node differential input channels. Power is provided to the accelerometer from the node excitation supply.

For additional information on LORD MicroStrain® accelerometers compatible for use with the V-Link® -LXRS® , see "Recommended Sensors" on page 63. For information on integrating other types of sensors not described in this manual, contact Technical Support (see "Technical Support" on page 60).

5.12 On-board Temperature Sensor

- The V-Link® -LXRS® has an on-board, solid state temperature sensor mounted on the surface of the circuit board.
- The temperature sensor output is connected to channel 8 of the V-Link® -LXRS®
- The temperature sensor has a measurement range of -25˚C to +70˚C range with an accuracy of ± 0.5˚C @25˚C.
- The sensor is made by Texas Instruments, and is part number LM60. Specifications may be found on the manufacturer's website.

5.13 Sensor Calibration

The input channels are configured with the Node Commander® software for the type of sensor and measurement being made, and can be displayed and recorded in volts, bits or engineering units. There are preset measurement types, designated by the measurement units, as well as a user defined field.

There are several methods accessible through the software for entering calibration values, or for in circuit sensor calibration including the use of the internal precision shunt resistor. The calibration is entered, or performed, for the particular node channel that the sensor is connected to and saved in the node memory for that channel. The calibration values are then applied when the software converts the raw voltage output of the sensors into the units designated during channel configuration.

NOTE

In order to achieve accurate readings, many sensors require calibration. Calibration accounts for the slight variations between sensor elements, wiring, system electronics, and sensor mounting and environmental conditions. The sensor calibration values can be entered through the Node Commander® software and are saved in the node memory for the applicable node channel.

See "Sensor Calibration Methods" on page 13 for more information about basic calibration methods in the software, and see "Using the Node Tester Board" on page 49 for an example using the Node Tester board,

6. Powering the Node

⚠WARNING

Apply only the input voltage range specified for the node, in the polarity indicated. Failure to do so could result in personal injury and permanent damage to the node. See "Safety Information" on page 72 for important safety considerations.

The node can be powered with the internal battery or an external source. These sources cannot be used simultaneously. One or the other is selected with a switch that is located inside of the node enclosure. When the node is manufactured, the switch is set to operate using the internal battery.

External battery holders and a ruggedized outdoor housing that accommodates two D cell batteries are available for the V-Link® -LXRS® , and can be used to extend battery operating capacity and duration. See "Node Accessories " on page 63 for more information.

6.1 Selecting the Power Source

The V-Link® -LXRS® can be powered by either the internal battery, or an external source. There is user accessible switch inside of the node to select the source. When the node is manufactured it is set to internal battery operation and charging. The following steps describe how to change between internal battery operation and an external power source.

⚠WARNING

The V-Link® -LXRS® Wireless Sensor Node contains an internal, rechargeable Lithium Polymer (Li-Po) battery. See "Safety Information" on page 72 for important precautions.

NOTICE

The electronics within the node are sensitive to static and moisture. Do not touch the internal circuitry or expose to liquids. Verify the main power switch to the node is OFF and the power supply disconnected before opening.

1. Verify the node power switch is in the OFF position and no external power is applied.
2. Remove the node cover screws with a 0.05” hex head wrench.
3. Use a small flat head screwdriver to push the recessed switch fully to the desired position, as indicated in Figure 28 - Power Source Selection. The figure shows the node configured for an external power source.
4. Once the setting is selected, fasten the node cover back in place.

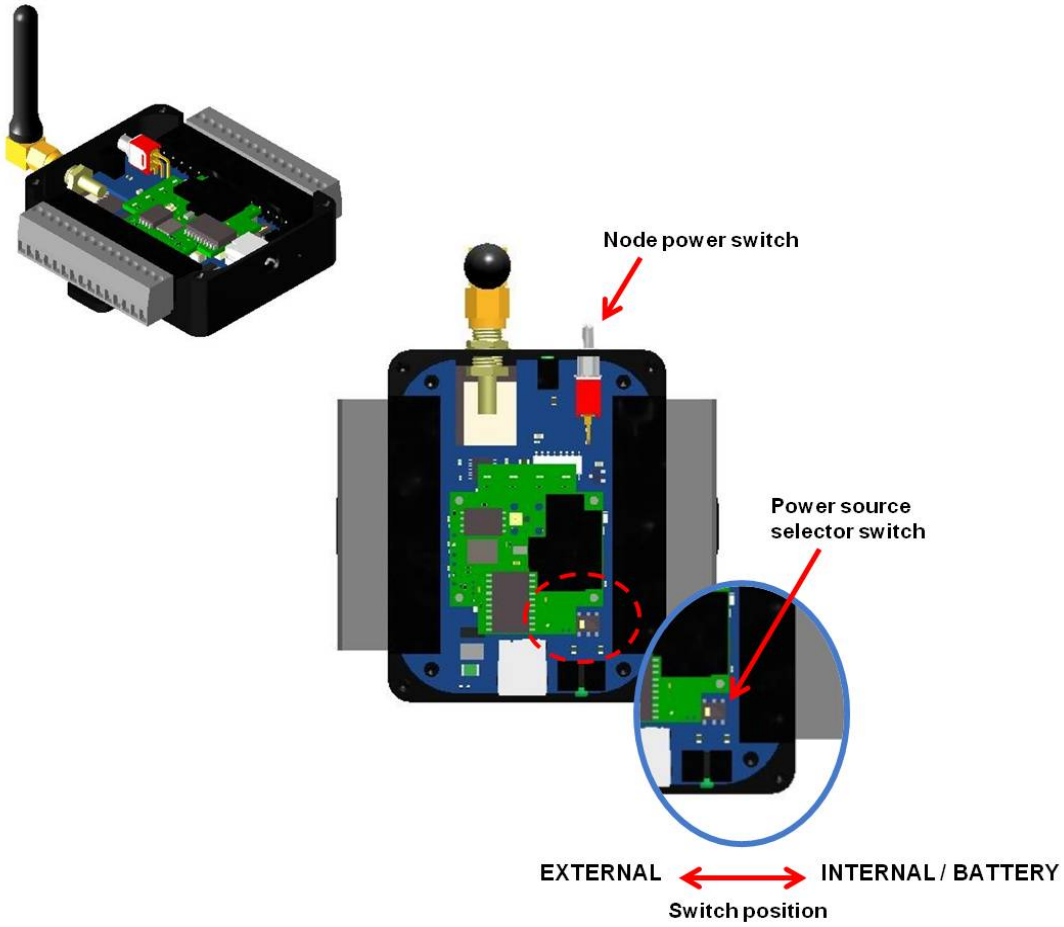


Figure 28 - Power Source Selection

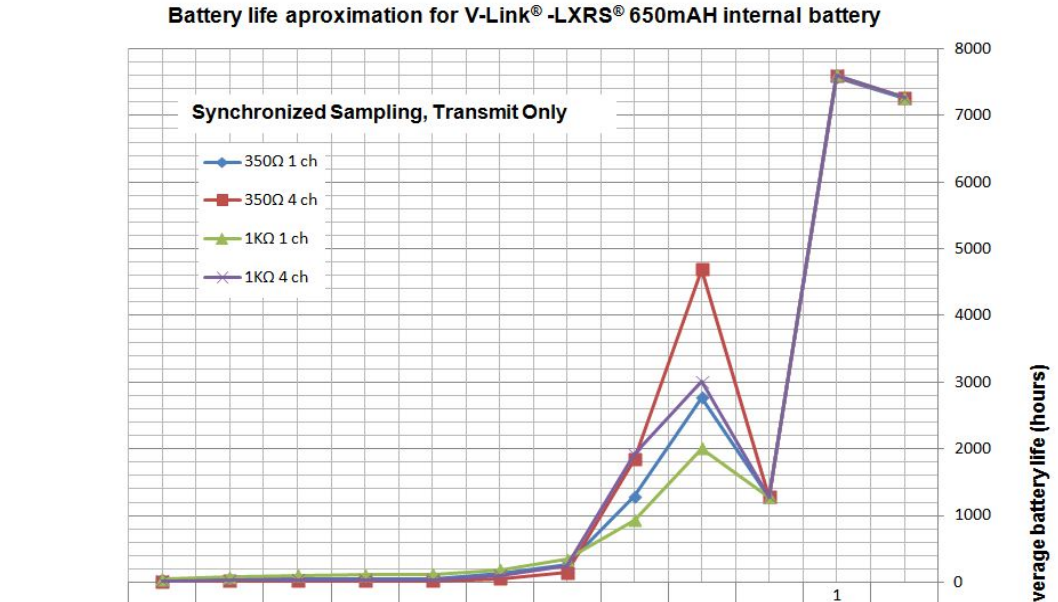
6.2 Using the Internal Node Battery

WARNING

The V-Link® -LXRS® Wireless Sensor Node contains an internal, rechargeable Lithium Polymer (Li-Po) battery. See "Safety Information" on page 72 for important precautions.

When the internal node switch is set for internal power, the node is powered by a rechargeable 650mAH lithium polymer battery. The battery is not user serviceable.

Node battery life is highly dependent on the number and type of sensors connected, and operational parameters such as sample mode and rate. More active channels and higher sample rates equate to decreased battery life. The following graph shows an example approximation of the battery life for a V-Link® -LXRS® with four different strain gauge sensor configurations, over a range of sample rates operating in Synchronized Sampling mode. See "Power Profile" on page 70 for additional V-Link® -LXRS® power specifications.



	512 Hz	256 Hz	128 Hz	64 Hz	32 Hz	16 Hz	8 Hz	4 Hz	2 Hz	1 Hz	1 sample per minute	sleep
350Ω 1 ch	32	44	51	54	57	125	264	1,288	2,772	1,275	7,574	7,262
350Ω 4 ch	12	13	15	16	17	56	141	1,839	4,695	1,276	7,589	7,264
1KΩ 1 ch	44	74	107	111	113	185	342	929	2,000	1,281	7,601	7,264
1KΩ 4 ch	19	24	32	36	40	100	243	1,913	3,008	1,279	7,602	7,264

6.3 Charging the Node Battery

⚠WARNING

Use only the power supply specified for the node to charge the battery. Using a power supply above the rated voltage could cause personal injury and permanent damage to the node. See "Safety Information" on page 72, for important safety considerations.

NOTE

Touching connected sensors and test boards, or charging the node battery while acquiring sensor data may induce noise on sensitive sensor signals and is not recommended.

1. Plug the node power supply into the node, and into a 120/240VAC, 50/60Hz AC power source. Use only the power supply specified for the node. Use the supplied power plug adapters, as needed.

2. Verify the charge indicator is red, and on brightly to indicate charging. If it is only on dimly a battery fault has occurred. Reset the node by unplugging power and then plugging it back in. The indicator should now turn on brightly. Continue charging until that indicator turns green to indicates a completed charge. Charging takes approximately 6-8 hours from a full discharge.

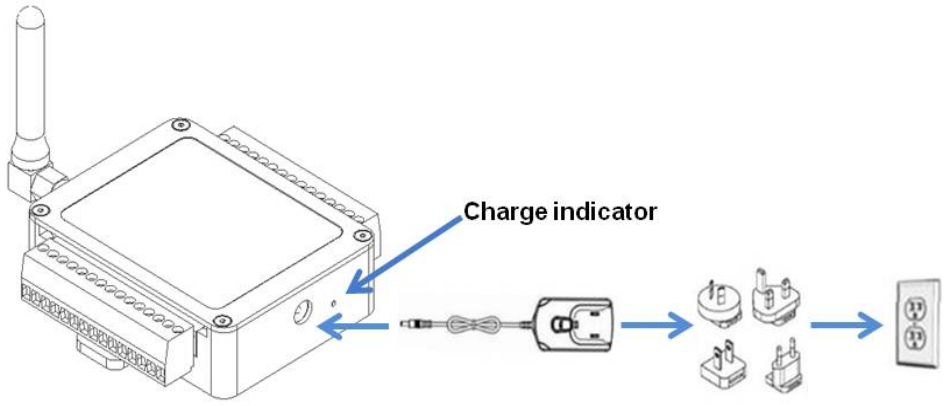


Figure 29 - Node Charging

6.4 Connecting an External Power Supply

⚠WARNING

Apply only the input voltage range specified for the node, in the polarity indicated. Failure to do so could result in personal injury and permanent damage to the node. See "Safety Information" on page 72 for important safety considerations.

When the internal node switch is set for external power, the node may be directly powered by the power supply specified for charging the node, or another regulated AC to DC power supply with the appropriate output parameters. It can also be powered by an external battery or other regulated DC supply. The supply must deliver a stable voltage between 3.2V and 9.0VDC, and be capable of sourcing at least 50mA. Power supplies over 9VDC, such as vehicle batteries, can be used by installing a step down regulator. See "Power Profile" on page 70 for V-Link® -LXRS® power use specifications. External battery holders and a ruggedized outdoor housing that accommodates two D cell batteries are available for the V-Link® -LXRS® . See "Node Accessories " on page 63.

External power is applied through either the power supply jack or the terminal block connectors. Do not connect both. Observe connection polarities or the node may be damaged.

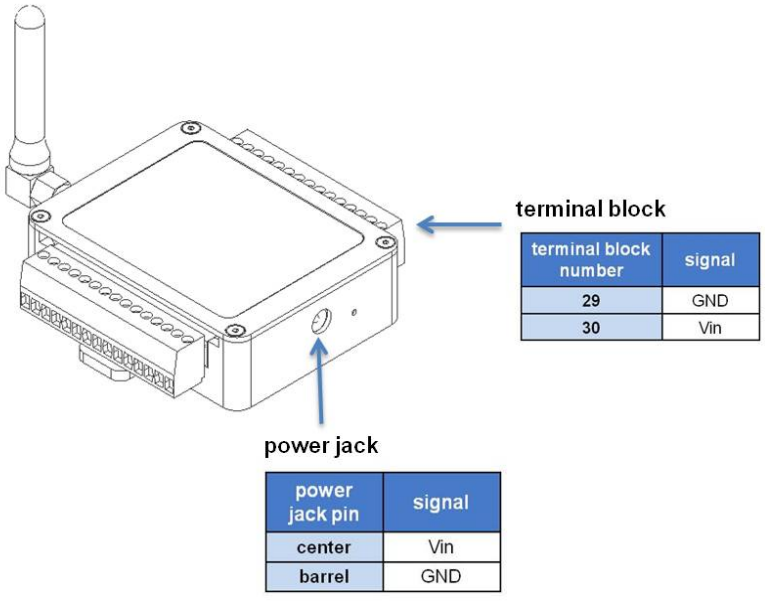
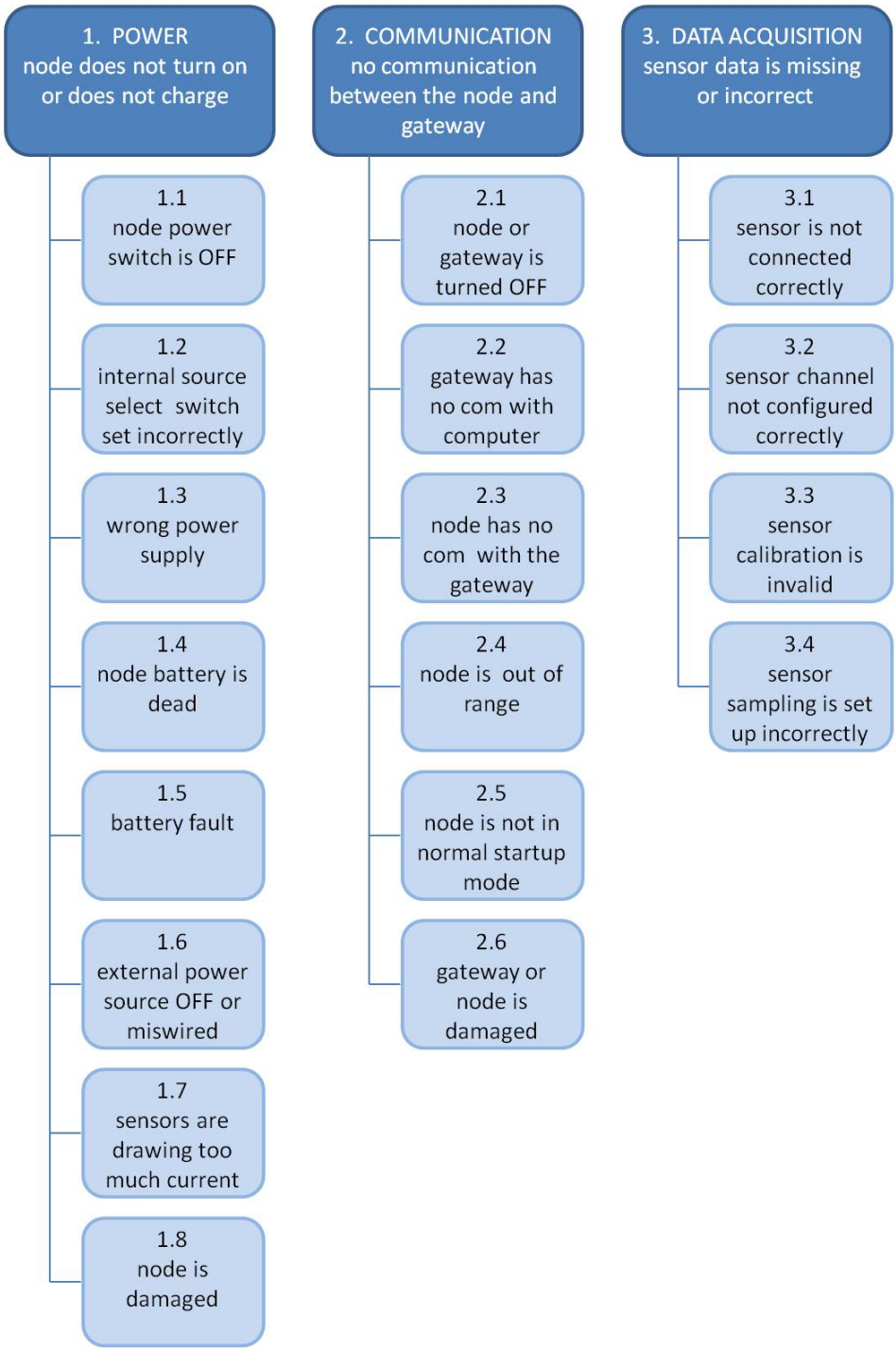


Figure 30 - External Power Connections

7. Troubleshooting

7.1 Troubleshooting Guide


1. POWER
node does not turn on or does not charge
1.1 node power switch is OFF
1.2 internal source select switch set incorrectly
1.3 wrong power supply
1.4 node battery is dead
1.5 battery fault
1.6 external power source OFF or miswired
1.7 sensors are drawing too much current
1.8 node is damaged
2. COMMUNICATION
no communication between the node and gateway
2.1 node or gateway is turned OFF
2.2 gateway has no com with computer
2.3 node has no com with the gateway
2.4 node is out of range
2.5 node is not in normal startup mode
2.6 gateway or node is damaged
3. DATA ACQUISITION
sensor data is missing or incorrect
3.1 sensor is not connected correctly
3.2 sensor channel not configured correctly
3.3 sensor calibration is invalid
3.4 sensor sampling is set up incorrectly

See "Interface and Indicators" on page 5 for indicator locations on the V-Link® -LXRS® , and see "Device Status Indicators" on page 48 for a complete summary of indicator meaning.

Problem	Possible cause and recommended solution
1. POWER **node does not turn on or does not charge**	**1.1 node power switch is off** The status indicator LED will be off. Toggle the switch upward to turn the node ON, and the status indicator LED should illuminate.
	1.2 internal source select switch is set incorrectly When the node is manufactured it is set to internal battery operation. To change to an external source see "Connecting an External Power Supply" on page 43.
	1.3 wrong power supply Using a power supply other than the one specified for charging, or an external supply that is outside of the node operating parameters could result in permanent damage to the node, or it may just not work. See "Node Accessories " on page 63.
	1.4 node battery is dead If the node power source is set to internal and the node will not power on, attempt to charge the node battery. See "Charging the Node Battery" on page 42. If the battery needs to replaced , contact Technical Support. See "Technical Support" on page 60
	1.5 battery fault If the battery charge indicator is only on dimly when charging is attempted, a battery fault condition has occurred. Unplug power and then plug it back in. The indicator should turn on brightly, indicating charging. See "Charging the Node Battery" on page 42
	1.6 external power is OFF or miswired If the node power source is set to external and the node will not power on, verify the power is wired correctly and turned ON. See "Connecting an External Power Supply" on page 43.
	1.7 sensors are drawing to much current The node battery can only supply 50mA to the connected sensors. If an over current condition occurs the node will shut down. Consider powering the node or sensors with an external source. See "Powering the Node" on page 39 for information about node power options, and see "Connecting Sensors" on page 21 for sensor power options.

Problem	Possible cause and recommended solution
	1.8 node is damaged If all power settings and connections have been verified, and the node is still unresponsive, contact Technical Support. See "Technical Support" on page 60
2. COMMUNICATION **no communication between the node and gateway**	**2.1 node or gateway is turned OFF** Verify the node and gateway have power applied and applicable power switches are on. Power is indicated on both devices by a status indicator LED.
	2.2 gateway has no communication with the computer Verify gateway communication in the software. Check, remove and reconnect communications and power cables, as applicable.
	2.3 node has no communication with the gateway Verify the gateway is operational and listening for nodes when the node is powered ON. If not, activate node discovery feature and cycle power to the node.
	2.4 node is out of range Perform a bench test with the node and gateway in close proximity to verify they are operational. See "Optimizing the Radio Link" on page 19 for node range test and installation recommendations. The node has been tested to operate up to 2km from the gateway with clear line of sight.
	2.5 node is not in normal start-up mode Turn the node on and watch the node device status indicator. See "Device Status Indicators" on page 48. If the node is in another start up mode, it can be bypassed by toggling the node ON/OFF switch rapidly three times, then leaving it in the ON position for normal power up. Start up mode can be changed in the software.
	2.6 gateway or node is damaged Verify all connections, power and settings. If available, try installing alternate nodes and gateways, one at a time, to see if the faulty device can be identified. If no conclusion can be determined, or to send a device in for repair, contact Technical Support. See "Technical Support" on page 60

Problem	Possible cause and recommended solution
3. DATA ACQUISITION **sensor data is missing or incorrect**	**3.1 sensor is not connected correctly** See "Connecting Sensors" on page 21 for common sensor wiring schemes, and verify connections. For non standard connections contact Technical Support (see "Technical Support" on page 60).
	3.2 sensor channel not configured correctly Verify the sensor is configured on the correct channel and has been enabled for data acquisition.
	3.3 sensor calibration is invalid If possible perform a field verification of the sensors by applying know loads and comparing the measured values. In the channel configuration settings, verify the sensor channel units are selected correctly. Verify the calibration calculations are correct. Verify the gain and offset range is correct and that the baseline offset is set with Auto Balance, as applicable. Verify the calibration values; the slope and offset, are correct. Verify all parameters were written to the node channel. Recalibrate as needed.
	3.4 sensor sampling set up incorrectly Verify sampling is active. Verify the sampling parameters are correct, including the sampling rate and mode. Verify the data location is where expected.

7.2 Device Status Indicators

The following is a complete summary of the V-Link® -LXRS® status indicators.

Indicator	Behavior	Node Status
Battery Charge Status Indicator	OFF	Node battery is not currently being charged
	ON bright red	Node battery is charging
	ON dim red	Battery fault condition, reset by unplugging power and then plugging it back in
	ON green	Battery is fully charged
Device Status Indicator	OFF	Node is OFF
	Ten rapid flashes when power is initially applied	Node is booting up normally
	1 second pulse (approximate)	Node is active and idle
	Continuously ON	Node is logging or streaming data
	Pulses at sample rate	Node is sampling in low duty cycle
	Pulses for each ping	Node is sending out communication requests
	Pulses at very high speed	Node is being range tested
	Several rapid pulses	Node EEPROM is being read or written
	Faint pulse at intervals	Node is sleeping with radio check intervals
	Four slow pulses when power is initially applied	Fault condition
	Five slow pulses when power is initially applied	Fault condition

Table 6 - Device Status Indicators

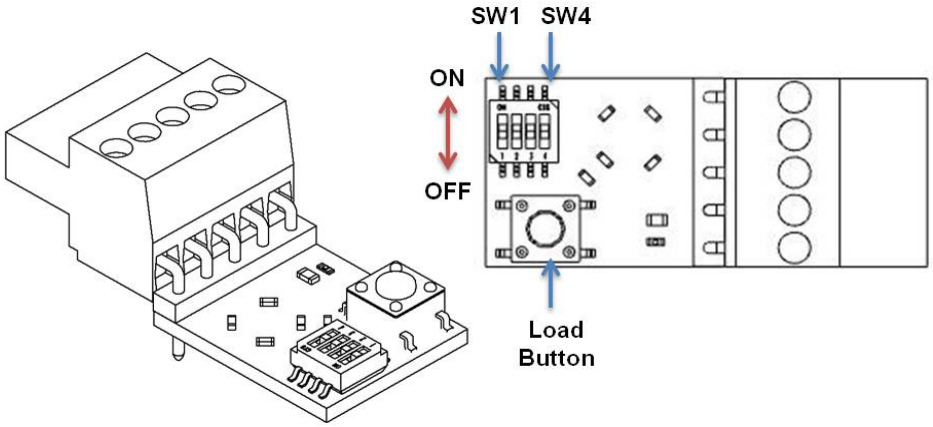
7.3 Using the Node Tester Board

The node tester board is used to verify node and network functions before sensors are connected, or for diagnostic purposes. The node tester board is used only on differential input channels, and provides a fixed load so system functions can be verified including basic operations not related to the sensor, such as communication and sampling.

There are various impedance value node tester boards available, depending on the node it is being used with. See "Parts and Configurations" on page 62 for configuration options and part numbers. Table 7 - Tester Board Configuration describes the strain gauge load settings available. This setting must match the type of node channel that is being tested. For example if the node is a quarter bridge node, the setting on the tester board must be the same. The configuration chart is also printed on the underside of the board.

NOTE

The switches may come with a protective film covering them. Simply peel the film off to access the switches.



Configuration	SW 1 position	SW 2 position	SW 3 position	SW 4 position
Full Bridge	ON	ON	ON	OFF
Half Bridge	OFF	OFF	ON	OFF
Quarter Bridge	OFF	OFF	OFF	ON

Table 7 - Tester Board Configuration

The following steps describe an example of how to use the tester board to sequence through the primary functions of the node and the wireless system. If the results indicated in the final steps are achieved, the system is fully operational for measuring a full bridge strain gauge. Other scenarios can be tested as needed.

1. Set the jumpers for Full Bridge operation, using a small flat head screw driver to fully push the switch into the desired position.

2. Verify the node is powered off and unplugged. If installed, remove the node terminal blocks from the node.

3. Plug the node tester board into the node Channel 1 position.

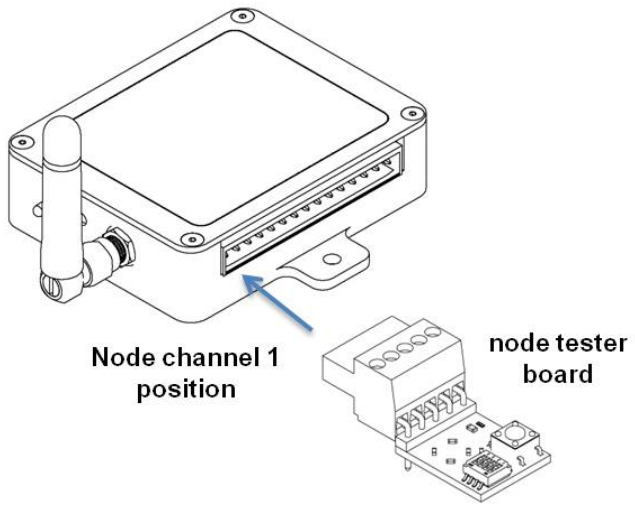


Figure 31 - Node Tester Board Installation

4. If not already, set up the Wireless Sensor Network equipment and install the Node Commander® software. See "Basic Setup and Operation" on page 4.

5. Launch theNode Commander® software and establish communications with the gateway and node.

6. Enter the node channel configuration menu by right clicking on the node heading in Node Commander® and selecting the Configure option, and Channels tab.

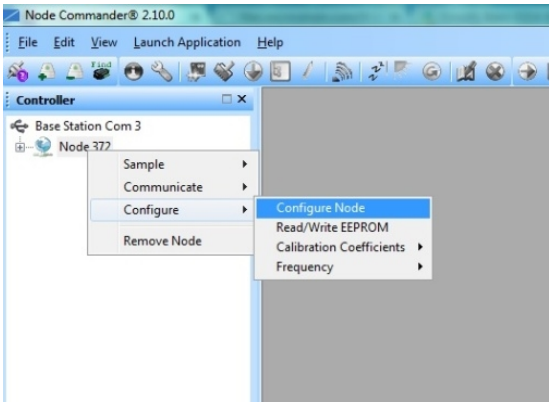


Figure 32 - Node Configuration Menu

7. Select the check box for Channel 1, which is where the Node Tester Board is installed, and then select Configure.

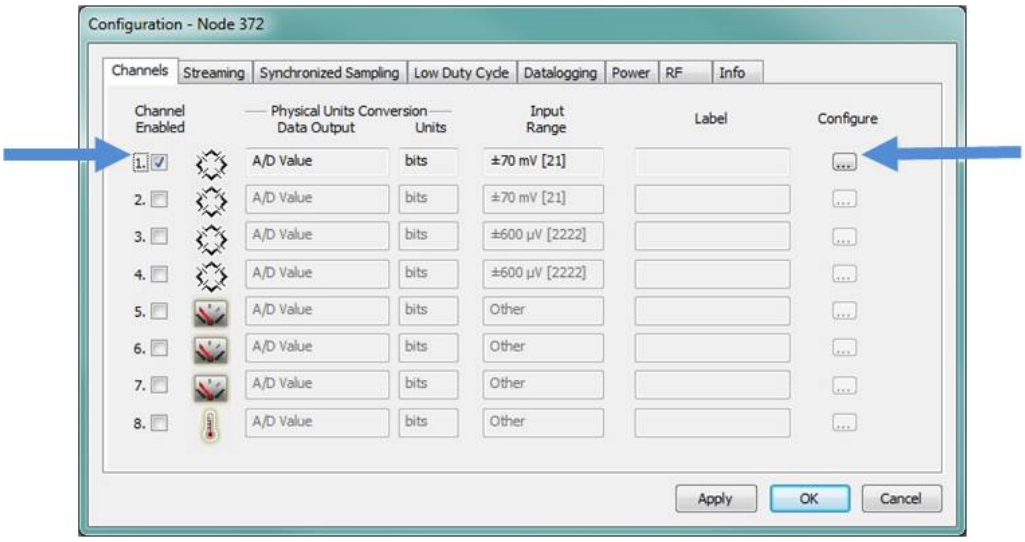


Figure 33 - Node Channel Configuration

8. Use the following settings for the node tester board.

    a. **Conversion Coefficients, Units:** uStrain

    b. **Coefficients, Class:** Strain

    c. **Conversion Coefficients, Units:** uStrain

    d. **PGA Settings, Input Range:** +/-2.5mV

    e. **PGA Setting:** Mid scale

9. Select the Auto Balance button to tare the no load value of the tester board.

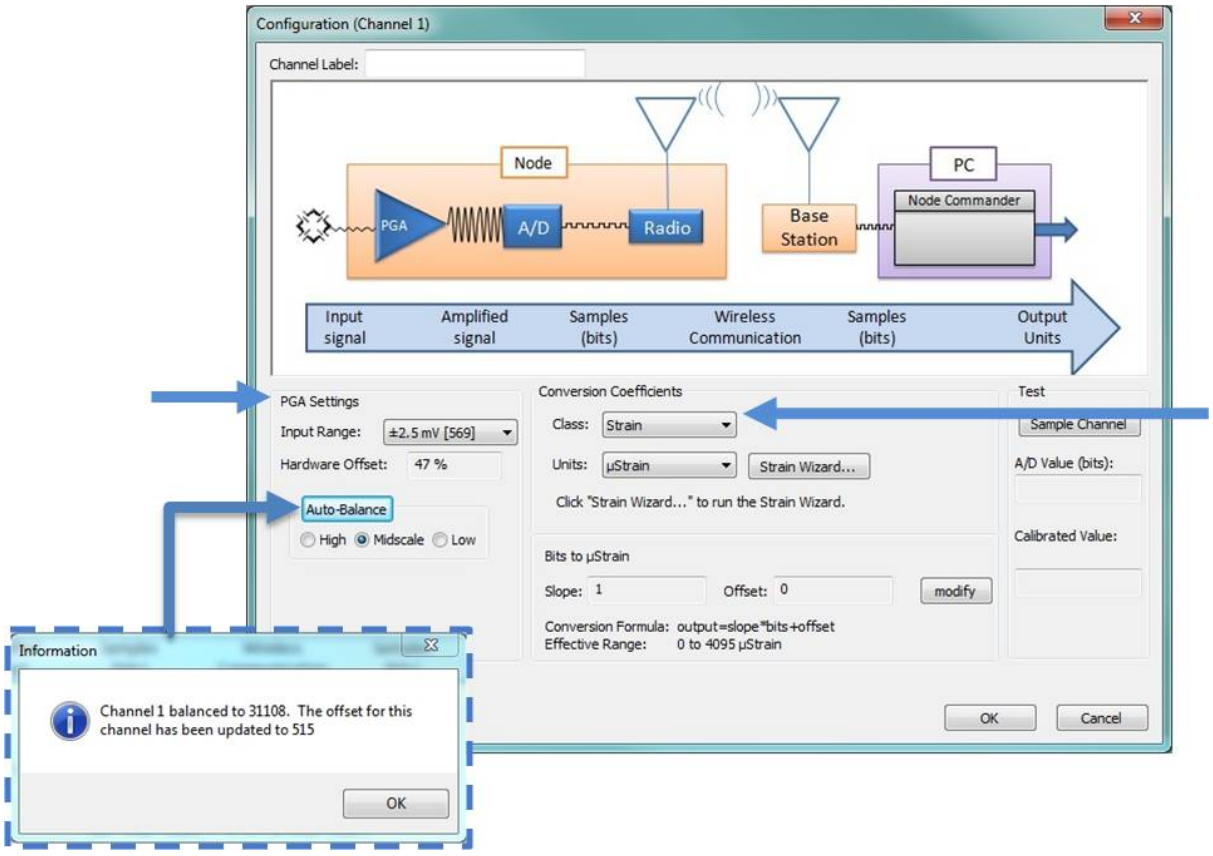


Figure 34 - Channel Settings

10. Select the Strain Wizard.

11. Select Full Bridge for the Bridge Type, Next, and then Use the Strain Measurement Wizard, Next.

12. Set the following for the Node Tester Board

    a. **Number of Active Gauges:** 4

    b. **Gauge Factor:** 2

    c. **Gauge Resistance:** (enter the node tester board ohm value)

    d. **Shunt Resistance:** 499000 ohms

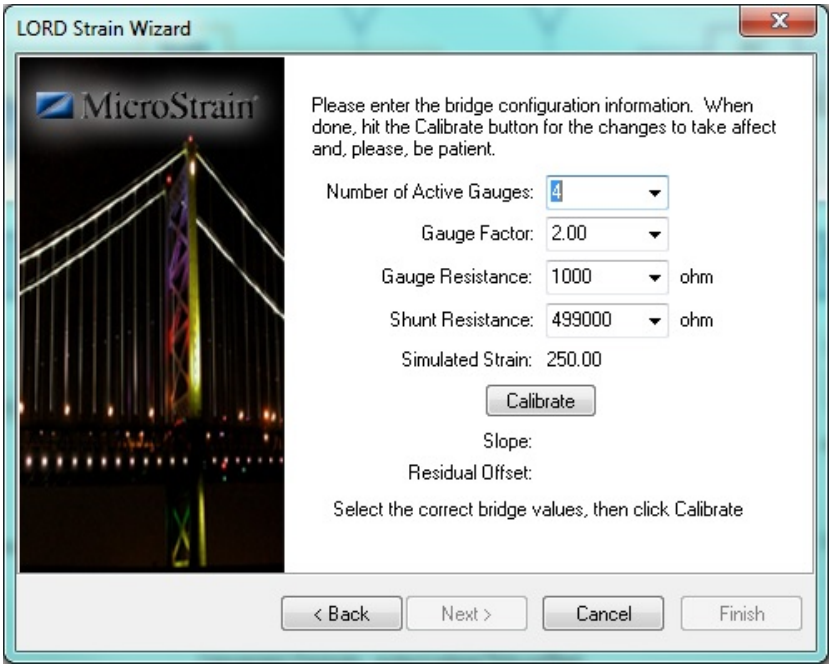

LORD Strain Wizard
MicroStrain
Please enter the bridge configuration information. When done, hit the Calibrate button for the changes to take affect and, please, be patient.
Number of Active Gauges: 4
Gauge Factor: 2.00
Gauge Resistance: 1000 ohm
Shunt Resistance: 499000 ohm
Simulated Strain: 250.00
Calibrate
Slope:
Residual Offset:
Select the correct bridge values, then click Calibrate
< Back
Next >
Cancel
Finish

Figure 35 - Strain Wizard Settings

13. Select Calibrate.

14. Verify the calibration looks as shown in Figure 36 - Strain Gauge Calibration. The green line represents the output of the strain gauge. With no load applied it should sit near the Auto Balance baseline value, as shown, and is represented by the red dashed line. During calibration, a shunt resistance (selecting on the Parameters page) is applied across the strain bridge, shown by the square pulse on the output. The Offset value, shown with the dashed blue line, is the average output value of the pulse and should sit across the top of the pulse. If the gauge has not had to time to equilibrate before sampling, or varying environmental factors exist, spikes in the gauge output may occur and affect the Baseline and Offset values. If this occurs, the Offset and Baseline values can be adjusted to clip the spikes in the output values. Adjust them as needed and select Accept when completed.

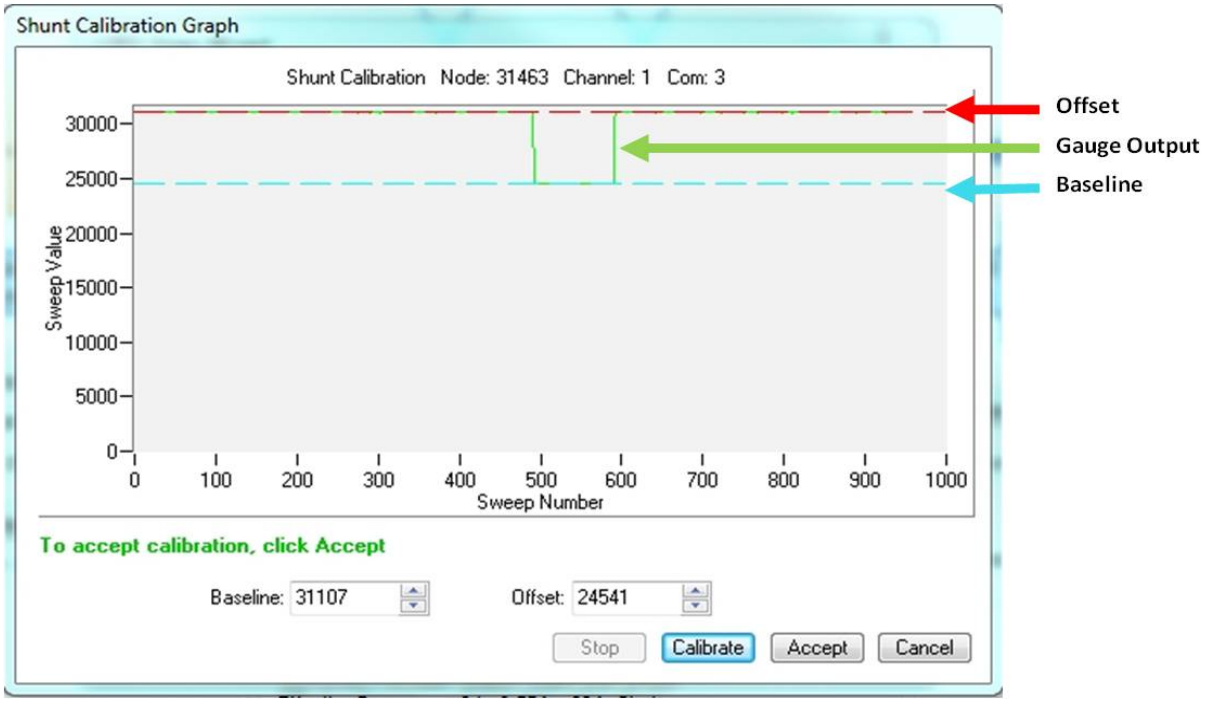


Figure 36 - Strain Gauge Calibration

15. Select Finish to end the Strain Wizard. Note the slope and offset values have been calculated.

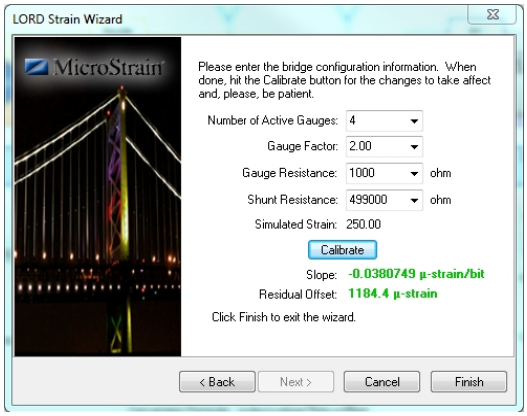

LORD Strain Wizard
MicroStrain
Please enter the bridge configuration information. When done, hit the Calibrate button for the changes to take affect and, please, be patient.
Number of Active Gauges: 4
Gauge Factor: 2.00
Gauge Resistance: 1000 ohm
Shunt Resistance: 499000 ohm
Simulated Strain: 250.00
Calibrate
Slope: -0.0380749 µ-strain/bit
Residual Offset: 1184.4 µ-strain
Click Finish to exit the wizard.
< Back
Next >
Cancel
Finish

Figure 37 - Completed Strain Wizard

16. Select OK to exit the Channel Configuration window.
17. In the Node Configuration window, select the Streaming tab. Uncheck Continuous Streaming and set the Time Duration to 15 seconds.
18. Select Apply to write configuration and calibration values to the node, then OK to exit.

NOTE

Touching connected sensors and test boards, or charging the node battery while acquiring sensor data may induce noise on sensitive sensor signals and is not recommended.

NOTE

There are many sampling options available in the Node Commander® software. The following describes just one option, for illustrative purposes.

19. Right click on the Node heading and then Sample, Stream, Start.

20. As soon as Start is selected, the node will start collecting data for duration of 15 seconds. During that time, press and release the load button on the node tester board to shunt the resistive load on and off. Verify the result is as shown in the figure below. The pulse value should equal tester board ohm value. Testing is complete.

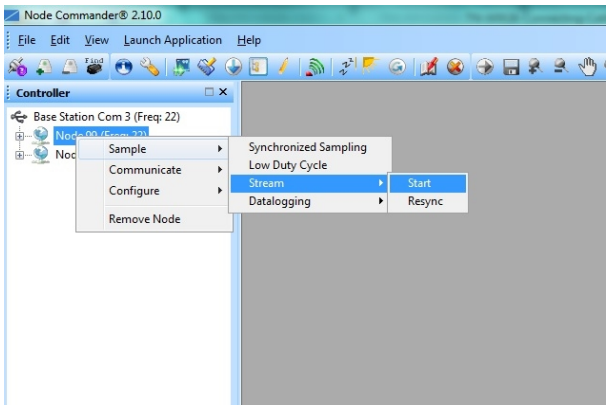


Figure 38 - Node Sampling Menu

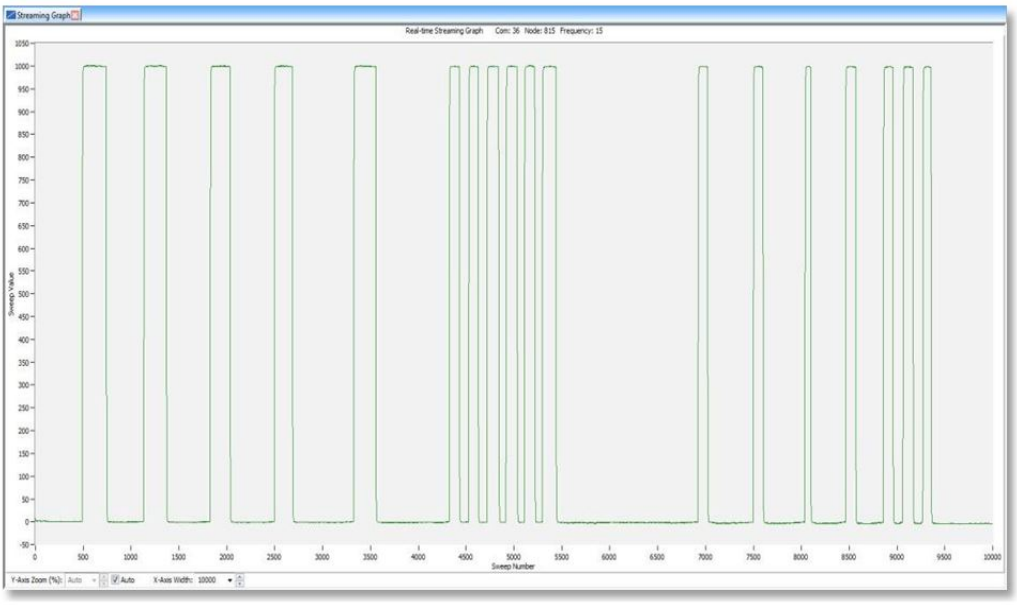


Figure 39 - Node Tester Output Stream

7.4 Updating Node Firmware

It is recommended that users continuously upgrade their devices to the latest available firmware to take advantage of improvements, and to minimize or correct operating issues. Node Commander® version 2.7.0 or greater can be used to update any mXRS® or LXRS® node or gateway firmware to the most current version. Updates are found on the LORD MicroStrain® website. Refer to the following Technical Support section for the web address.

1. Download the LXRS® Firmware Upgrade file from the LORD MicroStrain® website.

2. Once downloaded, extract the contents of the zip file into a folder on the computer. Verify there is a file with a .zhex extension.

3. Launch Node Commander® and establish communication between the node and gateway as normal.

4. Press and hold F1 on the computer keyboard. While holding F1, right-click the node heading and a drop-down menu will appear.

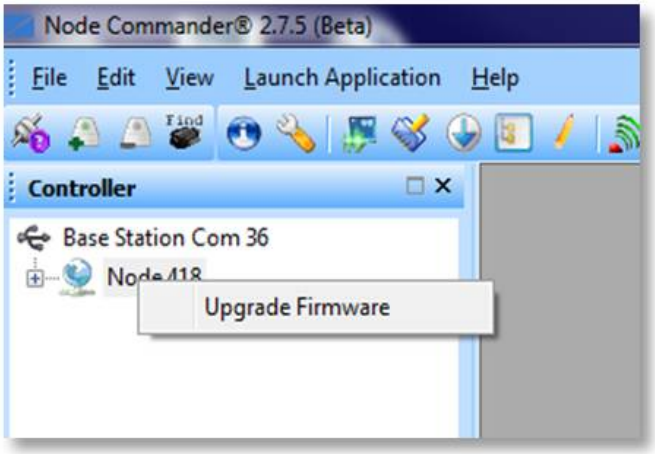


Figure 40 - Update Node Firmware

5. Release the F1 key.

6. Click Upgrade Firmware and the Node Firmware Upgrade window will appear.

7. Click Browse and navigate to the downloaded .zhex file.

8. Click Write and the upgrade sequence will begin. When complete, an Upgrade Success message will appear in the Status column.

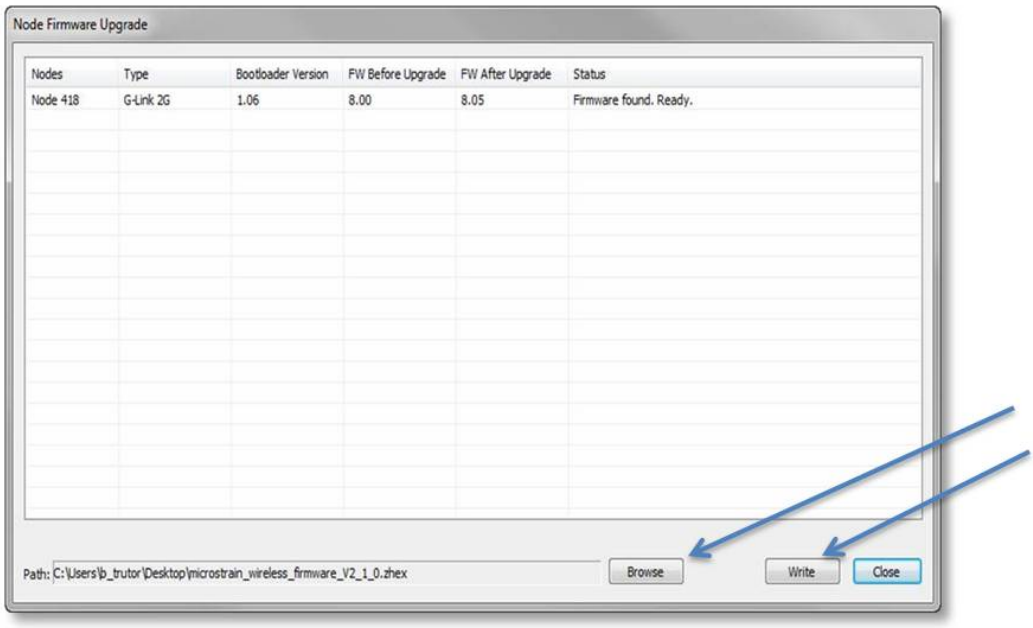


Figure 41 - Upgrade Firmware Window

7.5 Repair and Calibration

The V-Link® -LXRS® has no components which require factory calibration and certification.

General Instructions

In order to return any LORD MicroStrain® product, you must contact Sales or Technical Support to obtain a Return Merchandise Authorization number (RMA). All returned merchandise must be in the original packaging including manuals, accessories, cables, etc. with the authorization (RMA#) clearly printed on the outside of the package. Removable batteries should be removed and packaged in separate protective wrapping. Please have the LORD MicroStrain® model number and serial number as well as your name, organization, shipping address, telephone number and email. Normal turn-around for RMA items is 7 days from receipt of item by LORD MicroStrain®.

Warranty Repairs

LORD MicroStrain® warrants its products to be free from defective material and workmanship for a period of one (1) year from the original date of purchase. LORD MicroStrain® will repair or replace, at its discretion, a defective product if returned to LORD MicroStrain® within the warranty period. This warranty does not extend to any LORD MicroStrain® products which have been subject to misuse, alteration, neglect, accident, incorrect wiring, mis-programming or use in violation of operating instructions furnished by us, nor extend to any units altered or repaired for warranty defect by anyone other than LORD MicroStrain®.

Non-Warranty Repairs

All non-warranty repairs/replacements will receive a minimum charge. If the repair/replacement charge exceeds the minimum, LORD MicroStrain® will contact the customer for approval to proceed beyond the minimum with the repair/replacement.

7.6 Technical Support

There are many resources for product support found the LORD MicroStrain® website including technical notes, FAQs and product manuals.

http://www.microstrain.com/support_overview.aspx

For further assistance our technical support engineers are standing by to help with technical and applications questions.

Technical Support

sensing_support@LORD.com

Phone: 802-862-6629
Toll Free: 800-449-3878
Fax: 802-863-4093
SKYPE: microstrain.wireless.support

Live Chat is available from the website during business hours

9:00AM to 5:00PM (Eastern Time US & Canada)

8. Maintenance

There are no user serviceable parts on the V-Link® -LXRS® .

9. Parts and Configurations

9.1 Standard Nodes

For the most current product information, custom, and OEM options not listed below, refer to the LORD MicroStrain® website or contact the Sales Department.

Model Number	Description	LORD MicroStrain® Part Number
V-LINK-LXRS-M	• Four differential channels • Three single ended channels • Internal temperature sensor	**6312-1000**

Configuration Options (specify at time of order)

- **Full bridge configuration** on one or more differential channels.
- **350Ω or 1000Ω half bridge** completion on one or more differential channels.
- **350Ω or 1000Ω quarter bridge** completion on one or more differential channels.
- **High g-force** option. Node operates in gravitational forces in excess of 550g.

9.2 Node Accessories

The following parts are available for use with the V-Link® -LXRS® . For the most current product information refer to the LORD MicroStrain® website or contact the Sales Department. See "Sales Support" on page 66.

Description	LORD MicroStrain® Part Number
IP66/NEMA4X rated rugged outdoor enclosure for V-Link® -LXRS® with two D cell batteries capacity	**6313-3100**
Magnetic mounting strips for outdoor enclosure	**6302-4000**
1000Ω node tester board	**6313-8000**
350Ω node tester board	**6313-9000**
Power supply for node charging	**6313-6010**
Standard whip antenna (FCC compliant)	**9010-0048**
Inductive remote power starter for nodes	**6303-0300**
D cell battery tray for use with wireless nodes (indoor use)	**6302-0200**
AA cell battery tray for use with wireless nodes (indoor use)	**6302-0300**
Replacement terminal blocks	**9008-0272**

Table 8 - Node Accessories

9.3 Recommended Sensors

Many sensors can be used with the V-Link® -LXRS® . The following are sensors manufactured by LORD MicroStrain® and are supported for use with the V-Link® -LXRS® . For help with other sensor applications contact Technical Support (see "Technical Support" on page 60).

Description	LORD MicroStrain® Part Number
ACCEL-TRIAX-50, Triaxial Accelerometer, +/-50g	**6402-0310**
ACCEL-TRIAX-100, Triaxial Accelerometer, +/-100g	**6402-0110**
ACCEL-TRIAX-200, Triaxial Accelerometer, +/-200g	**6402-0210**
ACCEL-TRIAX-500, Triaxial Accelerometer, +/-500g	**6402-0410**

Table 9 - LORD MicroStrain® Sensors

9.4 Wireless System Equipment

Description	LORD MicroStrain® Part Number
WSDA-1000-SK, Wireless Sensor Data Aggregator Starter Kit. Includes Ethernet gateway, Ethernet communication cable, Node Commander® software and power supply.	**6314-0051**
WSDA-BASE-104-SK, USB Gateway Starter kit. Includes USB base station, USB cable, Node Commander® software and node charger.	**6307-1041**
WSDA-BASE-102-SK RS232 Gateway Starter Kit. Includes RS232 base station, RS232 cable, USB cable,Node Commander® software and node charger.	**6307-1021**
WSDA-BASE-101-SK Analog Gateway Starter Kit. Includes analog base station, USB cable, Node Commander® software and node charger.	**6307-1011**
WSDA-1000, Wireless Sensor Data Gateway with Ethernet	**6314-0050**
WSDA-BASE-104 USB Gateway	**6307-1040**
WSDA-BASE-102 RS232 Serial Output Gateway	**6307-1020**
WSDA-BASE-101 Analog Output Gateway	**6307-1010**
Node Commander® Software	**6301-0300**
Replacement USB cable	**9022-0029**
Replacement serial cable	**4005-005**
USB Gateway cable extender	**6307-0900**

Table 10 - Wireless System Equipment

9.5 Warranty Information

Warranty

LORD MicroStrain® warrants its products to be free from defective material and workmanship for a period of one (1) year from the original date of purchase. LORD MicroStrain® agrees to repair or replace, at its sole discretion, a defective product if returned to LORD MicroStrain® within the warranty period and accompanied by proof of purchase. This warranty does not extend to any LORD MicroStrain® products which have been subject to misuse, alteration, neglect, accident, incorrect wiring, mis-programming or to use in violation of operating instructions furnished by us, nor extend to any units altered or repaired for warranty defect by anyone other than LORD MicroStrain®. This warranty does not cover any incidental or consequential damages and is in lieu of all other warranties expressed or implied and no representative or person is authorized to assume for us any other liability in connection with the sale of our products. Some states do not allow limitations on how long an implied warranty lasts, and/or the exclusion or limitation of incidental or consequential damages so the above limitations and exclusions may not apply to the original customer.

Terms and Conditions of Sale

Please refer to the LORD MicroStrain®'s website Support page the complete Terms and Conditions of product sales.

Terms and Conditions of Service

Please refer to the LORD MicroStrain®'s website Support page the complete Terms and Conditions of product service.

Trial System

To enable customers to try our products risk free, LORD MicroStrain® offers a 30 day return on the purchase of a starter kit. In order to take advantage of this

offer, a purchase order or payment for the starter kit is required when the order is placed. If the product is not suited to the application, the product may be returned within 30 days from the date of receipt for a full refund (excluding shipping and handling), as long as the product is unaltered or undamaged. Items can only be returned after LORD MicroStrain® has issued an RMA. Items must be packed to withstand shipping and returned freight pre-paid. LORD MicroStrain® will inspect the items returned and issue a refund or credit once the items have been examined and are deemed to be unaltered or undamaged. Non-standard or custom products may only be returned with approval and a re-stocking penalty may be assessed. A 30 Day Return must be initiated by receiving a Return Material Authorization (RMA) from LORD MicroStrain®.

9.6 Sales Support

Products can be ordered directly from the LORD MicroStrain® website by navigating to the product page and using the Buy feature.

http://www.microstrain.com/wireless

For further assistance, our sales team is standing by to help with product selection, ordering options and questions.

Sales Support

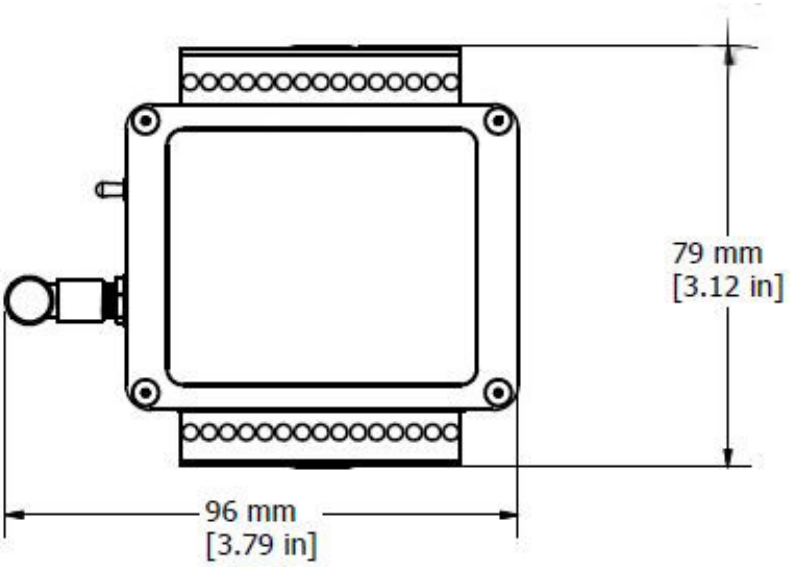
sensing_sales@LORD.com

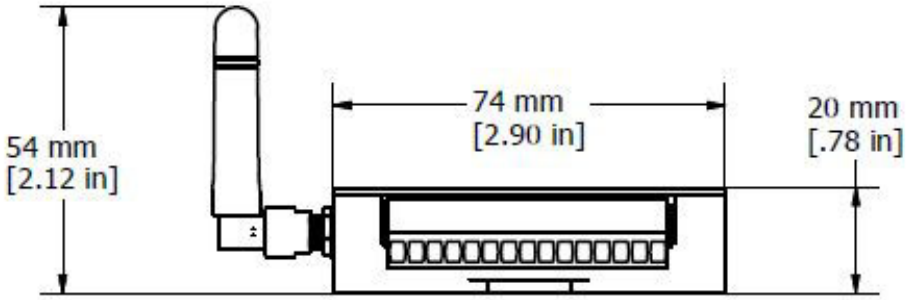
Phone: 802-862-6629
Toll Free: 800-449-3878
Fax: 802-863-4093

9:00AM to 5:00PM (Eastern Time US & Canada)

10. Specifications

10.1 Physical Specifications





Dimensions:	79mm x 96mm x 20mm
Weight:	141grams
Enclosure Environmental Rating:	General purpose indoor (IP67/NEMA4X rated enclosure available)

10.2 Operating Specifications

Parameter	Specification
Input channels	7 input channels: 4 full differential, 350 Ω resistance or higher (with optional bridge completion), and 3 single ended inputs (0-3 volts maximum), plus an internal temperature sensor
Temperature sensor	-40 °C to 70 °C range, typical accuracy ±2 °C (at 25 °C)
Anti-aliasing filter bandwidth	-3 dB cutoff at 250 Hz (factory adjustable)
Measurement accuracy	± 0.1% full scale typical
Resolution	1 bit: 0.024% 1 microstrain typical for 3 wire full bridge strain gauge when used in accordance with LORD MicroStrain® recommendations.
DC bridge excitation	+3VDC, 50mA maximum across all channels (pulsed to sensors for sample rates of 32 Hz and below to conserve power)
Programmable gain	software programmable for differential input channels from 21 to 13074 (can be reduced with custom configuration)
Programmable offset	software programmable
Analog to digital (A/D) converter	successive approximation type, 16 bit resolution
Data storage capacity	4 megabytes (approximately 1,000,000 data points)
Sampling modes	synchronized, armed datalogging, streaming, low duty cycle
Synchronized sampling rates	1 Hz - 512 Hz
Synchronized sampling mode network capacity	transmit real time data from node to PC - rate depends on number of active channels and transmitting nodes. sample rates and # of channels are configurable. For example; 3 nodes, 1 channel, 512 Hz, 15 nodes, 1 channel, 256 Hz 31 nodes, 1 channel, 128 Hz 63 nodes, 1 channel, 64 Hz
Synchronization between nodes	± 32µsec with 10 second beacon interval
Synchronization rate stability	± 3ppm
Armed datalogging sampling rate	1 channel enabled: 32 Hz to 4096 Hz; 2 or more channels enabled: 32 Hz to 2048 Hz
Streaming sampling rates	1 channel enabled: 736 Hz; 3 channels enabled: 617 Hz per channel; 8 channels enabled: 424Hz per channel
Low duty cycle sampling rates	512 Hz to 1 sample per 60 minutes
Event driven monitoring	user-definable event threshold trigger, 200K bytes pre- event datalogging and/or transmitting
Shunt calibration	channels 1 to 4, internal shunt calibration resistor 499KΩ
Radio frequency (RF) transceiver carrier	2.4 GHz direct sequence spread spectrum, license free worldwide (2.405 to 2.470GHz) over 14 channels, radiated power programmable from 0dBm (1mW) to 16dBm (39mW); European models limited to 10dBm (10mW)
RF data packet standard	IEEE 802.15.4, open communication architecture
RF data downloading	8 minutes to download full memory
Range for bi-directional RF link	programmable communication range from 70 meters to 2 kilometers
Status LED's	battery charging, battery charged, node status
Power	internal: 3.7 volt 650mAh lithium ion rechargeable battery; external: +3.2 to +9.0VDC
Power consumption	see power profile
Operating temperature	-20 ˚C to +60 ˚C with standard internal battery and enclosure, extended temperature range optional with custom battery and enclosure, -40 ˚C to +85˚C for electronics only
Maximum acceleration limit	500 g standard (high g option available)

Parameter	Specification
Dimensions	74 mm x 79 mm x 20 mm without antenna
Weight	141 grams
Enclosure material	aluminum
ROHS	compliant
Compatible gateways	all WSDA®-Base and WSDA®-1000
Software	SensorCloud™ Node Commander® Windows XP/Vista/7 compatible
Software development kit (SDK)	includes data communications protocol, EEPROM maps and sample code (OS and computing platform independent)
FCC ID	XJQMSLINK0003
IC ID	8505A-MSLINK0003

Table 11 - Operating Specification

10.3 Power Profile

Node power use is highly dependent on the number and type of sensors connected, and operational parameters such as sample mode and rate. More active channels and higher sample rates equate to increased power use. Below is an example approximation of the power use of a V-Link® -LXRS® with four different strain gauge sensor configurations, over a range of sample rates operating in Synchronized Sampling mode. This chart can be used to approximate external node power source requirements. See "Using the Internal Node Battery " on page 41 for V-Link® -LXRS® internal battery life specifications .

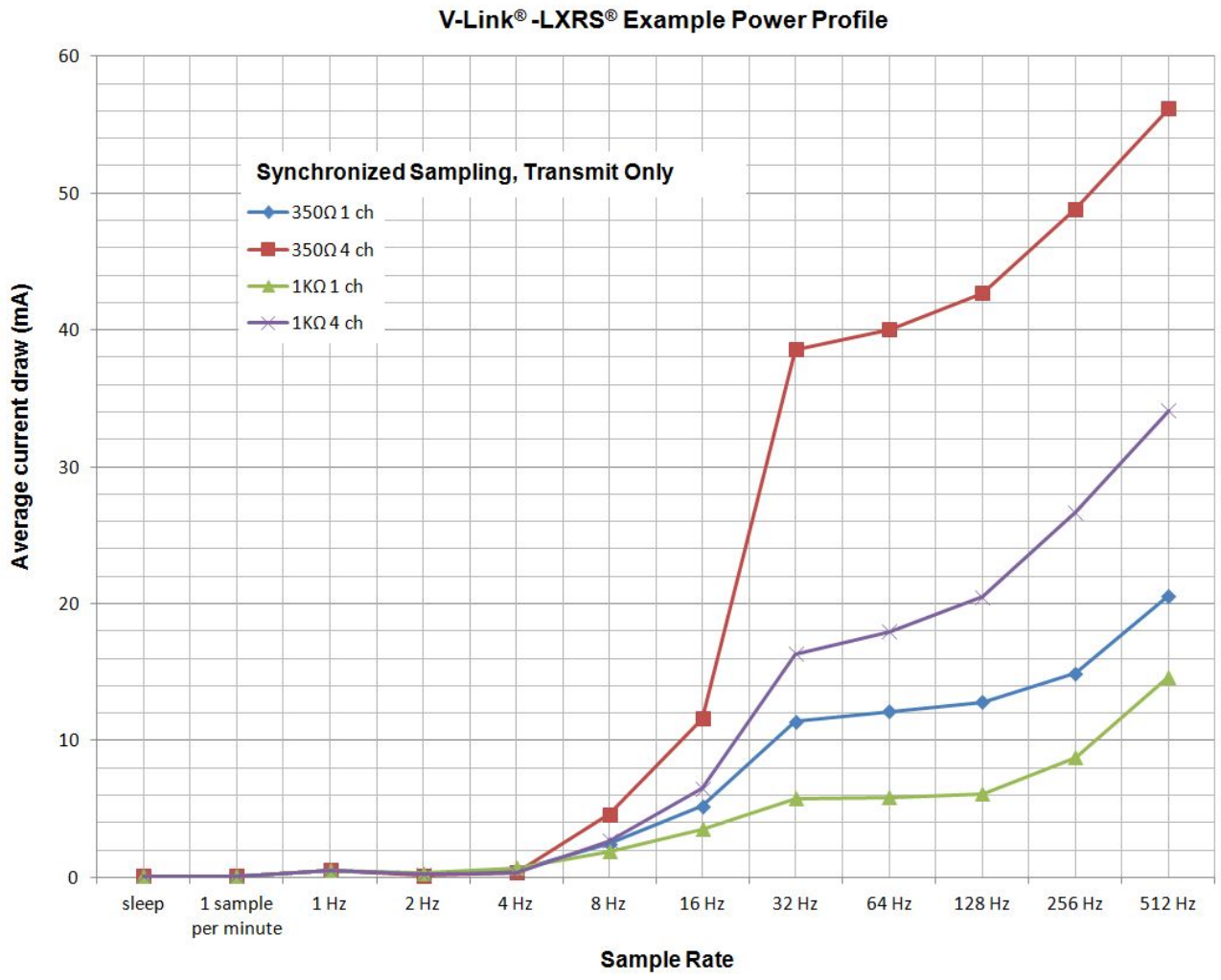


Figure 42 - Example V-Link® -LXRS® Power Profile

10.4 Radio Specifications

TheV-Link® -LXRS® Wireless Sensor Node employs a 2.4GHz IEEE 802.15.4 compliant radio transceiver for wireless communication. The radio is a direct-sequence spread spectrum radio and can be configured to operate on 14 separate frequencies ranging from 2.405 GHz to 2.480GHz. Following the 802.15.4 standard, these frequencies are aliased as channel 11 through channel 24. For all newly manufactured nodes, the default setting is equivalent to 2.425GHz (channel 15).

For standard models, radiated transmit power is programmable from 0dBm (1mW) to 16dBm (39mW). For European models transmit power is limited to 10dBm (10mW).

The radio complies with ETSI EN 300 328, EN 300 440 Class 2, FCC CFR-47 Part 15 and ARIB STD-T66. The radio is license free worldwide. Using antennas and transmission equipment other than what is provided with the node may void FCC compliance.

NOTE

The default operating frequency setting for newly manufactured nodes and gateways is 2.425GHz (channel 15). When using the Node Discovery feature in Node Commander®, the gateway listens for node broadcasts on the channel it is set to. The node provides this broadcast only when it is initially powered on, and broadcasts on all channels. As long as the node is powered on after the Node Discovery feature is activated, the gateway will link to it and it is not necessary to match the frequency setting of the node and gateway. The gateway automatically manages nodes that are operating of different frequencies. Setting channels is only required in frequency sensitive applications, or when multiple gateways are attached to one host computer.

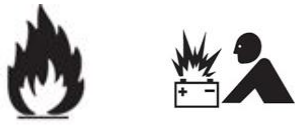
11. Safety Information

This section provides a summary of general safety precautions that must be understood and applied during operation and maintenance of components in the LORD MicroStrain® Wireless Sensor Network. Throughout the manual ANSI Z535 standard safety symbols are used to indicate a process or component that requires cautionary measures.

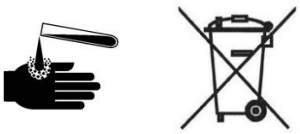
11.1 Battery Hazards

⚠WARNING **⚠CAUTION** ***NOTICE***

The V-Link® -LXRS® Wireless Sensor Node contains an internal, rechargeable Lithium Polymer (Li-Po) battery. Li-Po batteries are a fire and explosion hazard. Do not store or operate the node at temperatures above 212°F (100°C). Do not disassemble, short circuit, crush, puncture or otherwise misuse the battery.



When recharging the node internal battery, use only the power supply specified for node charging, and follow the instructions. See "Charging the Node Battery" on page 42. Applying a voltage above the input range may result in dangerous battery conditions, or cause permanent damage to the node.



Li-Po batteries contain toxic chemicals that are harmful to humans and the environment. Disposal is subject to federal and local laws. Do not discard the battery or the node in the trash. Follow proper battery disposal protocol, or contact LORD MicroStrain® Technical Support for information on extracting the battery or returning the product for proper recycling and disposal.

11.2 User Configurable Power Settings

The V-Link® -LXRS® Wireless Sensor Node can be powered by either the internal battery, or an external source. There is user accessible switch inside of the node to select the source. The default setting for this switch is for internal battery operation and charging.

⚠CAUTION **NOTICE**

Connecting an external power source when the node is set to internal power could result in injury or permanent node damage. See "Connecting an External Power Supply" on page 43 for details on how to adjust the switch setting.

- If the node is set to use an external source and the charging power supply is plugged in, it will power the node from the power supply, and not charge the battery. It will continue to use the internal battery.

- If the node is set to internal, and an external powers supply other than the one used for charging is plugged in, several things could happen. If it is a power supply that is in the operating range of the charging circuit it may charge the battery. If it is below the range of the charging circuit, nothing will happen. If the applied voltage is above the range of the charging circuit, damage to the node will likely occur and personal injury may result.

- When under battery operation there is a limit to how much current the node can provide to sensors. If the node is in an over current condition it will shut off until the cause is removed. Using an external power source for the node or sensor can mitigate this issue.

12. References

12.1 Related Documents

Many references are available on the LORD MicroStrain® website including product user manuals, technical notes and quick start guides. These documents are continuously updated and new applications added, and may provide more accurate information than printed or file copies. Listed below are a few that are pertinent to the V-Link® -LXRS® .

Document	Where to find it
Product Datasheets	http://www.microstrain.com/wireless/sensors
Product Manuals and Technical Notes	http://www.microstrain.com/support/docs
Product Application Notes	http://www.microstrain.com/applications
NIST Calibration Procedures	http://www.nist.gov/calibrations/
ASTM Testing Procedures	http://www.astm.org/Standard/standards-and-publications.html

Table 12 - Related Documents

12.2 Glossary

These terms are in common use throughout the manual:

ASTM: Association of Standards and Testing, nationally accepted organization for testing and calibration of technological devices.

Base Station: The base station is the transceiver that attaches to the host computer and provides communication between the software and the node(s); also referred to as a "gateway".

Bits: The digital equivalent of voltage on the node.

Calibration: To standardize a measurement by determining the deviation standard and applying a correction, or calibration, factor.

Configuration: A general term applied to the node indicating how it is set up for data acquisition. It includes settings such as sampling mode and rate, number of active channels, channel measurement settings, offsets, hardware gain, and calibration values.

Cycle Power: A command transmitted to the node to re-boot the node, either through a hardware or software switch.

Data Acquisition: The process of collecting data from sensors and other devices.

Data Logging: The process of saving acquired data to the system memory, either locally on the node, or remotely on the host computer.

DHCP (network): Dynamic Host Configuration Protocol is the standardized networking protocol used on Internet Protocol (IP) networks that automatically configures devices that are attached to it by assigning and configuring the device IP address.

Differential (signal): is a method of transmitting electrical signals in which they are paired together, as a differential pair, and measured with reference to each other only. This method makes the pair less susceptible to electrical noise.

EMI: Electromagnetic Interference is inductive or radiated disturbance that can create signal degradation on electrical signals, including loss of data.

Firmware: The code that is programmed onto a microcontroller or similar device in an embedded system that includes device operation commands, conditions, memory allocation and many other tasks.

Gateway: The gateway is transceiver attaches to the host computer and provides communication between the software and the node(s); also known as a "base station".

Host (computer): The host computer is the computer that orchestrates command and control of attached devices or networks.

LED: Light Emitting Diode is an indicator light that is used in electronic equipment.

LOS: Line of Sight is an acronym used in radio communications that describes the ideal condition between transmitting and receiving antennas in a radio network. As stated, it means they are in view of each other with no obstructions.

NIST: National Institute of Standards and Testing is a nationally accepted organization for testing and calibration of technological devices.

Node: The node is the wireless transceiver that the sensors are connected to, and provides communication with the gateway. The G-Link® -LXRS®, V-Link® -LXRS®, and SG-Link® -LXRS® are all nodes made by LORD MicroStrain®.

Node Tester board: The Node Tester board is a device designed by LORD MicroStrain® that can be plugged into nodes in order to test functionality.

Offset: When describing a mathematically linear relationship, the offset is the value where the line that represents the relationship in a graph crosses the y axis. The equation of a straight line is: $y = mx+b$, where "x" is the x axis coordinate, "y" is the y axis coordinate, "m" is the slope and "b" is the offset.

Ping: A byte of transmitted by the gateway to the node and the node responds by echoing the byte, indicating communication exists between them.

PGA: Programmable Gain Amplifier is an electronic device used to amplify small electrical signals.

Range Test: A continuous string of pings used to validate communication between the gateway and the node over distance and obstruction.

Read/Write EEPROM: Commands transmitted to the node to read or write parameters stored in the node's operating system.

RFI: Radio Frequency Interference

RSSI: Received Signal Strength Indication is a measurement of the transmission power in a radio signal. The untis are decibels per meter (dBm).

RS232: A serial data communications protocol

Sensor: A device that physically or chemically reacts to environmental forces and conditions and produces a predictable electrical signal as a result.

Sleep: A command transmitted to the node to set a node into sleep configuration.

Sampling: The process of taking measurements from a sensor or device.

Sampling Mode: The type of sampling that is being utilized, such as event triggered, continuous, or periodic. The nodes have several sampling modes that employ these types of sampling.

Sampling Rate: The frequency of sampling

Single Ended: Electrical signals that are measured with reference to a system ground.

Slope: When describing a mathematically linear relationship, the slope is the steepness of the line that represents that relationship on a graph. The equation of a straight line is: y = mx+b, where “x” is the x axis coordinate, “y” is the y axis coordinate, “m” is the slope and “b” is the offset.

Streaming: Streaming is a sampling mode in which all active channels (and the sensors attached to them) are measured, and the data acquired is transmitted to the gateway and software. The data is not written to non-volatile memory during streaming. Streaming can either be finite (have a user defined start and end time) or continuous (continue until the power is cycled on the node).

USB: Universal Serial Bus, a serial data communications protocol

Wheatstone Bridge: An electrical circuit used to measure unknown electrical resistances.

WSN: Wireless Sensor Network